QUALIFICATION AWAITING ACCREDITATION

OCR
Oxford Cambridge and RSA

GCSE (9–1)
Delivery Guide

GATEWAY SCIENCE PHYSICS A

J249
For first teaching in 2016

Radioactivity

Version 1

www.ocr.org.uk/physics

Introduction

GCSE (9–1) GATEWAY SCIENCE PHYSICS A

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- Content: A clear outline of the content covered by the delivery guide;
- Thinking Conceptually: Expert guidance on the key concepts involved, common difficulties students may have, approaches to teaching that can help students understand these concepts and how this topic links conceptually to other areas of the subject;
- Thinking Contextually: A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resources.feedback@ocr.org.uk

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'These draft qualifications have not yet been accredited by Ofqual. They are published (along with specimen assessment materials, summary brochures and sample resources) to enable teachers to have early sight of our proposed approach.

Further changes may be required and no assurance can be given at this time that the proposed qualifications will be made available in their current form, or that they will be accredited in time for first teaching in 2016 and first award in 2018.

P6.1a	recall that atomic nuclei are composed of both protons and neutrons, that the nucleus of each element has a characteristic positive charge
P6.1b	recall that atoms of the same elements can differ in nuclear mass by having different numbers of neutrons
P6.1c	Use the conventional representation for nuclei to relate the differences between isotopes to include identities, charges and masses
P6.1d	recall that some nuclei are unstable and may emit alpha particles, beta particles, or neutrons, and electromagnetic radiation as gamma rays
P6.1e	relate these emissions to possible changes in the mass or the charge of the nucleus, or both
P6.1f	use names and symbols of common nuclei and particles to write balanced equations that represent radioactive decay
P6.1g	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)
P6.1h	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
P6.1i	recall that changes in atoms and nuclei can also generate and absorb radiations over a wide frequency range (to include an understanding that these types of radiation may be from any part of the electromagnetic spectrum which includes gamma rays)
P6.1j	explain the concept of half-life and how this is related to the random nature of radioactive decay
P6.1k	calculate the net decline, expressed as a ratio, during radioactive emission after a given (integral) number of half-lives (M1c, M3d) to include half-life graphs (HT)
P6.1l	recall the differences in the penetration properties of alpha-particles, beta-particles and gamma-rays

General approaches:

An approach to teaching the structure of the atomic nuclei is to make it more visual for learners. Learners could be provided with string and beads of 2 different colours. One colour for protons and one for neutrons. Teachers may display an element from the periodic table on the board and ask the learners in pairs to model it. This can be taken further to model isotopes, which is highlighted by statements P6.1a-c. Radioactive decay (P6.1d-g) could be introduced by pairing learners up and providing each group with a sheet containing several radioactive decay equations. Learners should be able to note down change in atomic mass and number which should help them to explain what has changed in terms of the numbers of protons and neutrons.

Common misconceptions or difficulties learners may have:

Learners find it difficult to understand the concept of half-life and giving the net decline using a ratio (P6.1k). To overcome the difficulty learners may be provided with 100 wooden cubes with one side coloured and asked to put them into a beaker and shake them out over a table and remove those with the coloured side up. Once removed learners should record the number remaining and use these to repeat the process till no blocks remain. They can use these results to plot a graph of number of cubes remaining against number of throws. This should give them a curve resembling a half-life decay graph. They can use the graph to determine how many throws it takes to halve the number of blocks. This can be related to actual half-life graphs which look at activity and time taken to understand the concept with a little more clarity.

During radioactive decay learners find it difficult to understand that when a beta particle is released a neutron is turned into a proton. Generally they think it is an electron being released as on the radioactive decay equation it is illustrated with a negative sign. Extra care needs to be taken when explaining the equations.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

The atomic model (P6.1a) is a key concept which is fundamental in the topic `Matter (P1.1a-c)`. Ensuring clear understanding early is critical.

Introduction to electromagnetic radiation (P6.1d) has occurred in a previous topic `The electromagnetic spectrum (P5.2a, b and g)`.

The knowledge and understanding of P6.1 'Radioactive emission' is fundamental for future topics such as P6.2 `Uses and hazards of radioactive decay` and P8.3 `Beyond Earth`.

Approaches to teaching the content:

Learners are to look into the death of Russian ex-spy Alexander Litvinenko that has been linked to the presence of a 'major dose' of radioactive polonium-210 in his body. Learners are to use their knowledge of radioactive materials and research to explain how this may have caused his death. This may be written as a literacy report or a presentation. A good place to start could be http://news.bbc.co.uk/1/hi/health/6181688.stm

Activity 1

Skittlarium

TES
https://www.tes.com/teaching-resource/skittlarium-3009559

A practical to illustrate half-life and half-life graphs using skittles or smarties. Good introduction to half-lifes.

Activity 2

Misconceptions about radioactivity

Furry elephant
http://furryelephant.com/content/radioactivity/teaching-learning/radioactivity-misconceptions/

A number of simulations, which focus on misconceptions learners may encounter.

Activity 3

Atoms & Nuclei

Nuffield Foundation
http://www.nuffieldfoundation.org/practical-physics/atoms-and-nuclei

A series of experiments, which help to develop ideas of the atom.

Activity 4

Teaching Radioactivity

Institute of Physics
http://www.iop.org/education/teacher/resources/radioactivity/page_41558.html

Videos, animations and resources, which are useful when teaching radioactivity.

Activity 5

Radioactivity and radiation revision

YouTube
https://www.youtube.com/watch?v=cFMXgisrwpM

The video is a good revision source, which covers most aspects of the topic.

Activity 6

Decay equations worksheet

TES
https://www.tes.com/teaching-resource/worksheet--decay-equations-6099067

A good worksheet for learners to fill in the correct numbers to balance nuclear decay equations.

Activity 7

Radioactivity PowerPoint

TES
https://www.tes.com/teaching-resource/radioactivity-powerpoint-for-gcse-science-6015267

A PowerPoint, which clearly goes through radioactivity along with a quiz at the end.

Activity 8

Nuclear physics

echalk
http://www.echalk.co.uk/science/physics.html

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.

P6.2a	recall the differences between contamination and irradiation effects and compare the hazards associated with these two
P6.2b	explain why the hazards associated with radioactive material differ according to the half-life involved
P6.2c	describe the different uses of nuclear radiations for exploration of internal organs, and for control or destruction of unwanted tissue
P6.2d	recall that some nuclei are unstable and may split, and relate such effects to radiation which might emerge, to transfer of energy to other particles and to the possibility of chain reactions to include knowledge of the term nuclear fission
P6.2e	describe the process of nuclear fusion to include knowledge that mass may be converted into the energy of radiation

General approaches:

An approach to introducing the medical uses of radioactive substances (P6.2c) is run a circus activity in the classroom. Provide factsheets around the classroom on how radiation is used to treat cancer, how gamma radiation is used to sterilise medical equipment, tracers (beta and gamma emitters) and how they are used to explore internal organs, and how x-rays are used in medical treatment. Learners can collect the information and complete the learner sheet that accompanies this delivery guide.

Nuclear fission (P6.2d) can be a hard concept to understand, a fun way of showing how it works would be to use animation in the classroom. The YouTube clip where ping pong balls have been placed on mousetraps to show the rate of reaction and convey the idea of it being a chain reaction would be suitable.

Common misconceptions or difficulties learners may have:

Learners tend to confuse the ideas of contamination and irradiation. Explanation of these two keywords needs to be done with care. Demonstrations using radioactive material may be used to help explain the difference.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

Nuclear fusion and nuclear fission (P6.2d, e) are a useful introduction to topics such as P8.2 `Powering earth` when learners are required to look at different energy sources (P8.2a, b) and P8.3 `Beyond earth`.

The knowledge and understanding of P6.2 'Uses and hazards' has many links with Topic P6.1 `Radioactive emissions'.

Approaches to teaching the content:

Learners can be given the scenario of working for Discovery Channel. Their brief is to look at the disasters of the Fukushima nuclear plant, which occurred during April of 2011 due to a tsunami. Learners can be asked to produce a news report/article which looks in depth at:

- What happened?
- How many reactors were there?
- What chain reactions occurred inside the reactors?
- What happened to the rods?
- The effects of the radiation?

This article, which explains the events of what happened, is a good starting point:
http://www.bbc.co.uk/news/world-asia-pacific-13017282

Activity 1

Uses of radioisotopes

Learner Resource 1

A research activity, which requires learners to work independently, to identify, uses of radioisotopes in medicine. Learner Resource 1 is a learner sheet to support this activity.

Activity 2

Nuclear fission vs fusion quiz

TES
https://www.tes.com/teaching-resource/fusion-v-fission-6060929

A quiz which compares nuclear fission with fusion.

Activity 3

Nuclear Fusion

TES
https://www.tes.com/teaching-resource/nuclear-fusion-6419875

A PowerPoint, which explains nuclear fusion.

Activity 4

What is nuclear fission

YouTube
https://www.youtube.com/watch?v=D91T-B-PVE0

The video can be used as a good way to introduce nuclear fission.

Activity 5

Nuclear fission chain reaction

YouTube
https://www.youtube.com/watch?v=0v8i4v1mieU

This video would be another good way to introduce nuclear fission with mousetraps and ping pong balls.

Activity 6

Nuclear radiation

Echalk
http://www.echalk.co.uk/science/physics.html

Simulations, which explain nuclear fission with and without annotation. Can pause, to play at your own pace.

Activity 7

Hazards from radioactive materials

BBC Bitesize
http://www.bbc.co.uk/schools/gcsebitesize/science/21c_pre_2011/energy/safehandlingradmatrev3.shtml

A good revision resource which explains the difference between contamination and irradiation.

Activity 8

Radiation Principles

YouTube
https://www.youtube.com/watch?v=szlPK1Msn0Y

This video explains the effects of contamination and irradiation.

Activity 9

Radioactivity

Institute of Physics
https://www.iop.org/resources/topic/archive/radioactivity/

A clear explanation of why hazards are associated to the half-life time. Good website for research task.

The small print

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