GCSE Subject Criteria for Science

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Contents

The criteria

Introduction

GCSE subject criteria set out the knowledge, understanding, skills and assessment objectives common to all GCSE specifications in a given subject.

They provide the framework within which the awarding organisation creates the detail of the specification.

Aims and learning outcomes

1. GCSE specifications in Science should encourage learners to be inspired, motivated and challenged by following a broad, coherent, practical, satisfying and worthwhile course of study. They should provide insight into and experience of how science works, stimulating learners' curiosity and encouraging them to engage with science in their everyday lives and to make informed choices about further study and about career choices.

2. GCSE specifications in Science must enable learners to:

    - develop their knowledge and understanding of the material, physical and living worlds;
    - develop their understanding of the nature of science and its applications and the interrelationships between science and society;
    - develop an understanding of the importance of scale in science;
    - develop and apply their knowledge and understanding of the scientific process through hypotheses, theories and concepts;
    - develop their understanding of the relationships between hypotheses, evidence, theories and explanations;
    - develop their awareness of risk and the ability to assess potential risk in the context of potential benefits;
    - develop and apply their observational, practical, enquiry and problem-solving skills and understanding in laboratory, field and other learning environments;
    - develop their ability to evaluate claims based on science through critical analysis of the methodology, evidence and conclusions;

- develop their skills in communication, mathematics and the use of technology in scientific contexts.

Subject content

3. The content of GCSE specifications in Science must reflect the learning outcomes.

4. GCSE specifications in Science must be consistent with the National Curriculum Key Stage 4 programmes of study requirements for England and Wales, and the statutory requirements for key stage 4 in Northern Ireland.

5. GCSE specifications in Science must require learners to develop the knowledge, skills and understanding specified below.

6. GCSE specifications in Science must ensure the qualification is comparable in content and range with other GCSE science qualifications.

7. GCSE specifications in Science must require learners to demonstrate knowledge and understanding of:

   - science as an evidence-based discipline;
   - the collaborative nature of science as a subject discipline and the way new scientific knowledge is validated;
   - how scientific understanding and theories develop and the limitations of science;
   - the importance of scale in terms of time, size and space;
   - how and why decisions about science and technology are made;
   - the evidence for the origin, structure and continuing evolution of the universe;
   - how the surface of the Earth and its atmosphere have changed since the Earth's origin and are still changing;
   - the Earth's crust, sea and atmosphere, and living organisms as the ultimate sources from which all useful materials are obtained or synthesised;

- the production, use and disposal of materials and how an understanding of biology and chemistry helps to reduce the resulting impacts on the environment;
- how, in chemical reactions, atoms are rearranged to make new products with different properties and no atoms are lost or made;
- chemical reactions including reduction and oxidation, neutralisation, electrolysis and polymerisation reactions;
- patterns in the chemical reactions between substances;
- how the properties of materials, including elements and compounds, can be explained by their chemistry;
- how the properties of materials determine their uses;
- the wave equation and the transfer of energy and information by waves;
- the relationship between the properties of electromagnetic waves and their uses;
- ionising radiations, including that they are emitted all the time by radioactive materials and that they can transfer energy;
- the generation and control of electrical power and the relationship between power, current and voltage;
- the distribution and uses of electricity;
- the relationship between power, energy and time;
- energy conservation, the efficiency of energy transfer and the associated economic and environmental implications;
- energy flow through the biosphere;
- cycling and recycling of nutrients including the roles of microorganisms;
- how environmental change is measured using living and non-living indicators;
- the interdependence of organisms and their adaptations to their environment;

- the variety of life, including microorganisms, plants and animals, variation within species including the effects of genotype and environment;
- how similarities and differences can be used to classify organisms and the importance of classification;
- natural selection and how it can lead to evolutionary changes, and how genes determine the structure and function of organisms;
- how animals and plants respond to external and internal changes and how organisms regulate internal systems;
- how human health is affected by a range of environmental and inherited factors, by the use and misuse of drugs and by medical treatment;
- hazard identification and the nature of risk;
- risk factors and risk assessment including potential benefit;
- the importance of working accurately and safely;
- ethical implications of science and its applications.

8. GCSE specifications in Science must require learners to develop the ability to:

- plan practical ways to answer scientific questions and test hypotheses; devise appropriate methods for the collection of numerical and other data; assess and manage risks when carrying out practical work; collect, process, analyse and interpret primary and secondary data including the use of appropriate technology; draw evidence-based conclusions; evaluate methods of data collection and the quality of the resulting data;
- use models to explain systems and processes; develop arguments and explanations, and draw conclusions using scientific ideas and evidence;
- communicate scientific information or ideas and scientific, technical and mathematical language[1], conventions and symbols.

[1] See Appendix A.

Assessment objectives

9. All specifications in Science must require learners to demonstrate their ability to:

	Assessment objectives	Weighting
AO1	Recall, select and communicate their knowledge and understanding of science.	30–40%
AO2	Apply skills, knowledge and understanding of science in practical and other contexts.	30–40%
AO3	Analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence.	25–35%

Scheme of assessment

10. GCSE specifications in Science must allocate a weighting of 75 per cent to external assessment and a weighting of 25 per cent to controlled assessment in the overall scheme of assessment.

11. Question papers in Science must be targeted at either foundation or higher tier.

Grade descriptions

12. Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by learners awarded particular grades. The descriptions must be interpreted in relation to the content in the specification; they are not designed to define that content.

13. The grade awarded will depend in practice upon the extent to which the learner has met the assessment objectives overall. Shortcomings in some aspects of learners' performance in the assessment may be balanced by better performances in others.

Grade	Descriptions
A	Learners recall, select and communicate precise knowledge and detailed understanding of science. They demonstrate a comprehensive understanding of the nature of science, its laws, its applications, and the influences of society on science and science on society. They understand the relationships between scientific advances, their ethical implications and the benefits and risks associated with them. They use scientific and technical knowledge, terminology and conventions appropriately and consistently, showing a detailed understanding of scale in terms of time, size and space. They apply appropriate skills, including communication, mathematical and technological skills, knowledge and understanding effectively in a wide range of practical and other contexts. They show a comprehensive understanding of the relationships between hypotheses, evidence, theories and explanations and make effective use of models to explain phenomena, events and processes. They use a wide range of appropriate methods, sources of information and data consistently, applying relevant skills to address scientific questions, solve problems and test hypotheses. Learners analyse, interpret and critically evaluate a broad range of quantitative and qualitative data and information. They evaluate information systematically to develop arguments and explanations taking account of the limitations of the available evidence. They make reasoned judgments consistently and draw detailed, evidence-based conclusions.
C	Learners recall, select and communicate secure knowledge and understanding of science. They demonstrate understanding of the nature of science, its laws, its applications and the influences of society on science and science on society. They understand how scientific advances may have ethical implications, benefits and risks. They use scientific and technical knowledge, terminology and conventions appropriately, showing understanding of scale in terms of time, size and space. They apply appropriate skills, including communication, mathematical and technological skills, knowledge and understanding in a range of practical and other contexts. They recognise, understand and use straightforward links between hypotheses,

	evidence, theories, and explanations. They use models to explain phenomena, events and processes. Using appropriate methods, sources of information and data, they apply their skills to answer scientific questions, solve problems and test hypotheses. Learners analyse, interpret and evaluate a range of quantitative and qualitative data and information. They understand the limitations of evidence and develop arguments with supporting explanations. They draw conclusions consistent with the available evidence.
F	Learners recall, select and communicate their limited knowledge and understanding of science. They have a limited understanding that scientific advances may have ethical implications, benefits and risks. They recognise simple interrelationships between science and society. They use limited scientific and technical knowledge, terminology and conventions, showing some understanding of scale in terms of time, size and space. They apply skills, including limited communication, mathematical and technological skills, knowledge and understanding in practical and some other contexts. They show limited understanding of the nature of science and its applications. They can explain straightforward models of phenomena, events and processes. Using a limited range of skills and techniques, they answer scientific questions, solve straightforward problems and test ideas. Learners interpret and evaluate some qualitative and quantitative data and information from a limited range of sources. They can draw elementary conclusions having collected limited evidence.

Appendix A: Mathematics requirements

These criteria contain as one of the learning outcomes the requirement for specifications to provide learners with the opportunity to develop their skills in communication, mathematics and the use of technology in scientific contexts. In order to deliver the mathematical element of this outcome, specifications and assessment materials must contain opportunities for learners to demonstrate scientific knowledge using appropriate mathematical skills.

The following represent the areas of mathematics that have been identified as arising naturally from the science content in the subject criteria.

While this is not a checklist for each question paper or assessment, awarding organisations must ensure that their assessment materials properly reflect these mathematical requirements, assessing the full range of mathematical skills over a reasonable period of time.

Learners are permitted to use calculators in all assessments.

Learners are expected to use units appropriately. However, not all questions need to reward the appropriate use of units.

Learners should be able to:

- Understand number size and scale and the quantitative relationship between units.
- Understand when and how to use estimation.
- Carry out calculations involving +, - , x, ÷, either singly or in combination, decimals, fractions, percentages and positive whole number powers.
- Provide answers to calculations to an appropriate number of significant figures.
- Understand and use the symbols =, <, >, ~.
- Understand and use direct proportion and simple ratios.
- Calculate arithmetic means.
- Understand and use common measures and simple compound measures such as speed.
- Plot and draw graphs (line graphs, bar charts, pie charts, scatter graphs, histograms) selecting appropriate scales for the axes.

- Substitute numerical values into simple formulae and equations using appropriate units.
- Translate information between graphical and numeric form.
- Extract and interpret information from charts, graphs and tables.
- Understand the idea of probability.
- Calculate area, perimeters and volumes of simple shapes.

In addition, higher tier learners should be able to.

- Interpret, order and calculate with numbers written in standard form.
- Carry out calculations involving negative powers (only –1 for rate).
- Change the subject of an equation.
- Understand and use inverse proportion.
- Understand and use percentiles and deciles.

Awarding organisations may add to this list to enable them to draw upon other areas of mathematics in their assessments without significantly impacting on the level of demand of the specification.

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