

# edexcel GCSE SCIENCES

## Accredited specification

Edexcel GCSE in Further Additional Science 2SF01



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Issue 2

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This specification is Issue 2. Key changes are sidelined. We will inform centres of any changes to this issue. The latest issue can be found on the Edexcel website: [www.edexcel.com](http://www.edexcel.com)

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## Introduction

The Edexcel GCSE in Further Additional Science is designed for use in school and colleges. It is part of a suite of GCSE qualifications offered by Edexcel.

The GCSE Further Additional Science qualification is designed to allow an alternative pathway to three science GCSEs, of GCSE Science, GCSE Additional Science and GCSE Further Additional Science. These qualifications cover the same content as the three GCSEs in Biology, Chemistry and Physics.

This qualification does not meet the KS4 programme of study for science (which is covered in the study of GCSE Science). However, this qualification builds on knowledge and skills developed in GCSE Science, and GCSE Additional Science. It is expected that students will have completed the KS4 programme of study through studying GCSE Science, and also GCSE Additional Science, before attempting this qualification.

This qualification does not follow the subject criteria for any of the GCSEs in Science, Additional Science, Biology, Chemistry and Physics. However, it uses identical content to that which can be found in units B3, C3, and P3 from the Biology, Chemistry and Physics GCSEs, as well as a controlled assessment unit.

## About this specification

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### Why choose Edexcel?

#### Every student can fulfil their potential

We are here to help you ensure that every student can fulfil their potential. At Key Stage 4 this is done by ensuring that they have the qualification they need to find work or progress to further learning.

To help students fulfil their potential, we have developed a new suite of GCSEs for Science that puts good science at the heart of teaching, learning and assessment and:

- is based on an extremely clear and detailed specification
- has exam papers designed and trialled to contain appropriate stretch
- has a clear and achievable approach to new requirements for controlled assessment and practical work
- is designed to allow you to choose the best learning pathway for each student
- supports you with help available online, on the phone and locally.

## **An extremely clear and detailed specification**

You will see that the specification is extremely detailed. This is to:

- make it easy for you to plan
- make sure you don't have to cover material twice in successive units because the progression of ideas is clear.

## **Exam papers designed and trialled to contain appropriate stretch**

Our GCSEs bring with them regulatory requirements to test students using a variety of question types. The types we have included are:

- objective questions
- short answer questions
- longer answer questions, testing quality of written communication.

Using research undertaken by our Assessment Design team and in consultation with teachers, we have developed exam papers that are:

- clear – the language is carefully checked and simple rules are followed for consistency
- able to stretch the students aiming for higher grades – longer answer questions are carefully written to ensure more able students know what they need to do to access all the marks and to ensure students aiming for lower grades can gain some marks
- consistent – to ensure that students are familiar with the paper style. This includes producing Sample Assessment Materials using the same quality control processes as live papers.

## **An achievable approach to new requirements for controlled assessment and practical investigations**

We have designed the controlled assessment and theory content to ensure that the controlled assessment:

- is easy to plan
- is straightforward to mark
- follows a structure that helps test students' actual investigative skills
- is based on students' own practical work and collection of secondary evidence – as required by the Ofqual subject criteria.

To help with planning and to develop skills, we have embedded a small number of practical investigations in theory units. The benefits are twofold:

- development of knowledge and skills can happen simultaneously, thus maximising teaching time
- a mix of theory and practical learning is more likely to lead to secure acquisition of knowledge and skills.

Knowledge of these practical investigations and the ability to interpret the data that can result from them can be assessed in the examination papers. The best way to ensure this is to undertake the practical investigations.

### **Controlled assessment – Planning, Observations and Conclusions (POC)**

To allow students to experience what a full investigation is like, within the limitations of a real school environment, the controlled assessments have been split into three parts – Planning, Observations and Conclusions. Marks from each can be submitted separately or submitted as a set. Whole task responses, from which marks have been submitted, should be retained for moderation.

For each controlled assessment we will produce specific marking support to help you apply the generic marking criteria. All controlled assessments are marked to these generic criteria regardless of subject. This means that you can apply generic criteria to award marks where a student gives an answer that you see is correct, but falls outside the specific marking guidance for that controlled assessment.

### **Designed to allow you to choose the best learning pathway for each student**

Depending on the learning approach that suits them, and the progression route that they wish to follow, different learning pathways can suit different students.

There's a great deal of shared content between BTEC Applied Science and our new GCSE Science suite, as both are based on the Key Stage 4 Programme of Study. We've turned this overlap to your advantage by creating highly flexible KS4 Science learning pathways. The volume of shared content means you can take your time to choose the progression route that best meets your students' needs and most fits their learning approach.

We'll provide you with high-quality guidance and comprehensive teaching schemes, enabling you to identify the best pathway for your students. You can use the schemes to set work that provides evidence that meets BTEC criteria and also forms a valuable part of your GCSE teaching. This will help you to:

- see if a student works best with the BTEC approach or the GCSE approach
- delay the decision on moving students completely to BTEC or GCSE, or allowing them the option of gaining both a GCSE and a BTEC qualification – depending on whether they become more interested in following a vocational or academic route
- have evidence gathered towards BTEC assignments for any students that move to a full BTEC course
- ensure you can cover GCSE teaching in the time available even if you are allowing students to try the BTEC approach early on in your Key Stage 4 teaching
- introduce some of the motivational aspects of the BTEC approach to all your students.

### **Supporting you with help available online, on the phone and locally**

We recognise that the changing nature of teaching, with less time to travel to training, the need to continually review whether the expectations of students, parents and the community are being met, and a greater number of qualifications to offer means that you need more support available more quickly than ever before.

To help you we have committed to delivering expert support locally, online and at the end of the phone.

- We will be running free Launch and Getting Ready to Teach events
- There will be online events at 4pm so you don't have to miss teaching
- We will be working with your LA to provide you with the information and support you need. Look out for cluster groups and briefings in your area.
- If you have individual needs, you can call us to find out if an advisor can speak to you or visit you to discuss how to meet those needs.
- Our Science Subject Advisor team is on the end of the phone to help you with both subject-related and administrative queries.
- Our website is being radically updated. Visit [www.edexcel.com/Science/](http://www.edexcel.com/Science/) to find:
  - free teaching resources
  - free information on teaching GCSEs in Science with BTEC
  - a free mocks resource
  - our ResultsPlus Mock Analysis Service – get an early feel for how your students are coping with the new exam styles
  - our Subject Advisor webpage and Ask the Expert services – proven to help you.



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# Specification at a glance

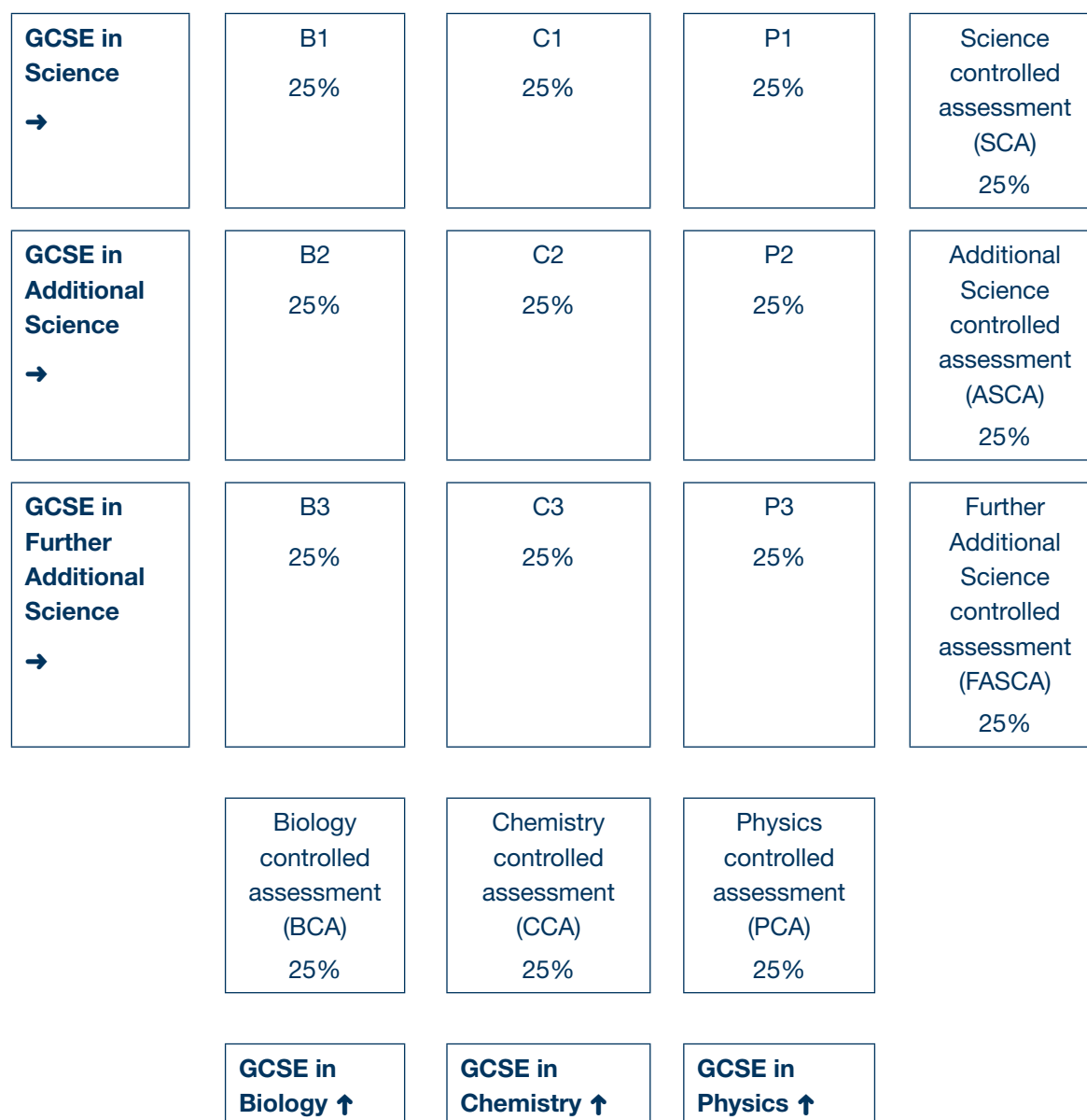
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## Units

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The suite of GCSEs in science qualifications are a nested set of qualifications:



Details of each unit are given on the following pages.

The Edexcel GCSE in Further Additional Science comprises four units:

- Units B3, C3, P3 and FASCA

In this specification bold text refers to higher tier only content. Italic text refers to practical investigations, which students should have completed.

All externally assessed units will be assessed by tiered examinations. Students will need to be entered for a specific tier at the time of entry.

Unit B3:	Using biology	*Unit code: 5BI3F/5BI3H
<ul style="list-style-type: none"><li>Externally assessed</li><li>Availability: June</li></ul>	25% of the total GCSE	
Overview of content		
This unit is split into three compulsory topics:		
<ul style="list-style-type: none"><li>Control systems</li><li>Behaviour</li><li>Biotechnology</li></ul>		
Overview of assessment		
<ul style="list-style-type: none"><li>This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions.</li><li>The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.</li></ul>		

Unit C3:	Chemistry in action	*Unit code: 5CH3F/5CH3H
<ul style="list-style-type: none"><li>Externally assessed</li><li>Availability: June</li></ul>	25% of the total GCSE	
<p>Overview of content</p> <p>This unit is split into five compulsory topics:</p> <ul style="list-style-type: none"><li>Qualitative analysis</li><li>Quantitative analysis</li><li>Electrolytic processes</li><li>Gases, equilibria and ammonia</li><li>Organic chemistry</li></ul>		
<p>Overview of assessment</p> <ul style="list-style-type: none"><li>This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions.</li><li>The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.</li></ul>		

Unit P3:	Application of physics	*Unit code: 5PH3F/5PH3H
<ul style="list-style-type: none"><li>Externally assessed</li><li>Availability: June</li></ul>	25% of the total GCSE	
<p>Overview of content</p> <p>This unit is split into five compulsory topics:</p> <ul style="list-style-type: none"><li>Radiation in treatment and medicine</li><li>X-rays and ECGs</li><li>Production, uses and risks of missing radiation from radioactive sources</li><li>Motion of particles</li><li>Kinetic theory and gases</li></ul>		
<p>Overview of assessment</p> <ul style="list-style-type: none"><li>This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions.</li><li>The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.</li></ul>		

Unit FASCA:	Further Additional Science controlled assessment	*Unit code: 5SF04
<ul style="list-style-type: none"> <li>Internally assessed</li> <li>Available for moderation: June</li> </ul>		<b>25% of the total GCSE</b>
<p>Overview of content</p> <ul style="list-style-type: none"> <li>For this unit students will complete one or more controlled assessment tasks related to Unit B3, C3 or P3 content.</li> <li>Each task consists of <b>three</b> parts. Part A is planning activity. Part B is an observation, collecting primary and secondary evidence. Part C consists of conclusions related to the primary and secondary evidence collected in Part B.</li> </ul>		
<p>Overview of assessment</p> <ul style="list-style-type: none"> <li>This unit is internally assessed under controlled conditions.</li> <li>There will be three tasks available each year – one task from B3, one task from C3, and one task from P3.</li> <li>Each task has a shelf life of one year.</li> <li>The tasks will be available to teachers one year in advance.</li> <li>Each task has three parts - Part A: Planning, Part B: Observations and Part C: Conclusions.</li> <li>The total number of marks available for the three parts is 50.</li> <li>Students must attempt all three parts of a task.</li> <li>If they attempt all tasks, then the best marks from Part A, B and C should be submitted for the unit.</li> </ul>		

\*See *Appendix 1* for a description of this code and all other codes relevant to this qualification.

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## External assessments (examination papers)

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Our overriding priority with exam papers is to ensure that:

- every student can show what they know, understand and are able to do
- every teacher knows what they must teach.

To do this we have produced a very detailed specification so that you and your students understand exactly what a student needs to know, understand and be able to do. To help you use this detailed specification, we have split it into topics.

Secondly we have carried out extensive work, using science experts in our Assessment Design team and working closely with our senior examiners, to develop an exam paper style that can be consistently delivered and will be familiar with students. It includes three types of question parts:

1. objective questions – used only where this will provide credible evidence of knowledge and skills
2. structured short answers – for maths, How Science Works or theory
3. longer answers worth six marks – to help provide stretch and challenge.

Papers are designed to allow students likely to get lower grades to achieve, while ensuring that some questions provide the stretch required to differentiate between students. Even the 6 mark question parts are designed with this aim.

Every question is designed to have an accessible starting point and then become more challenging. In addition, the paper itself is slightly ramped in difficulty. This maximises the opportunity for students to demonstrate their knowledge, understanding and skills in the exam.

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## Controlled assessment tasks (internal assessments)

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### **Practical investigations in theory units – the simplest way to plan controlled assessment**

The criteria for GCSEs in science indicate that an investigative approach to internal assessment is required. The best way to develop investigative skills is to embed practical work in your teaching of theory. The benefits are twofold:

- Development of knowledge, understanding and skills can happen together, thus saving time that can then be used by you in other aspects of your teaching
- A mix of theory and practical learning is more likely to lead to secure acquisition of knowledge and skills.

We have extended the benefit of this approach, if you choose to use it, by defining a small number of practicals in the theory units of the specification. Knowledge of these practical investigations, and the ability to interpret the data that can result, is required for exams.

### **Planning, Observations and Conclusions (POCs)**

To allow students to experience what a full investigation is like, within the limitations of a real school environment, the controlled assessment task has been split into three parts, Part A - Planning, Part B – Observations and Part C – Conclusions. Students are required to attempt all three parts of the task. However, students can do three tasks. The best part marks from across all tasks can be submitted for the unit.

There is a set of assessment criteria within this specification. This assessment criteria is generic across the controlled assessment tasks for the GCSEs in Additional Science, Further Additional Science, Biology, Chemistry and Physics. Edexcel will give additional guidance of the application on the generic assessment criteria in support documentation.

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## A Qualification content

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### Key subject aims

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#### **GCSE in Further Additional Science**

This GCSE qualification in Further Additional Science encourages students to be inspired, motivated and challenged by following a broad, coherent, practical, satisfying and worthwhile course of study. It encourages learners to develop their curiosity about the living, material and physical worlds and provide insight into and experience of how science works. It enables learners to engage with science and to make informed decisions about further study in science and related subjects and career choices.

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### Knowledge and understanding

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This Edexcel GCSE in Further Additional Science qualification requires students to demonstrate knowledge and understanding of:

- science as an evidence-based discipline
- the collaborative nature of science as a subject discipline, the way new scientific knowledge is validated and the limitations of science
- the importance of working accurately and safely
- hazard identification and the nature of risk
- risk factors and risk assessment in the context of potential benefit
- the importance of scale in terms of time, size and space in science
- the use of modelling, including mathematical modelling to explain aspects of science



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## Skills

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This Edexcel GCSE in Further Additional Science provides students with the opportunity to develop the ability to:

- develop hypotheses and plan practical ways to test them including risk assessment; manage risks when carrying out practical work; collect, process, analyse and interpret primary and secondary data including the use of appropriate technology to draw evidence-based conclusions; review methodology to assess fitness for purpose, and review hypotheses in light of outcomes
- use scientific theories, models and evidence to develop hypotheses, arguments and explanations; develop and use models to explain systems, processes and abstract ideas
- communicate scientific information using scientific, technical and mathematical language, conventions and symbols
- represent chemical reactions by word equations and simple balanced equations where appropriate.

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## How Science Works

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The GCSE in Further Additional Science requires the students to develop the skills, knowledge and understanding of *How Science Works*, described as follows.

### **Data, evidence, theories and explanations**

1. the collection and analysis of scientific data
2. the interpretation of data, using creative thought, to provide evidence for testing ideas and developing theories
3. many phenomena can be explained by developing and using scientific theories, models and ideas
4. there are some questions that science cannot currently answer and some that science cannot address

### **Practical and enquiry skills**

5. planning to test a scientific idea, answer a scientific question or solve a scientific problem
6. collecting data from primary or secondary sources, including the use of ICT sources and tools
7. working accurately and safely, individually and with others, when collecting first-hand data
8. evaluating methods of data collection and considering their validity and reliability as evidence

### **Communication skills**

9. recalling, analysing, interpreting, applying and questioning scientific information or ideas
10. using both qualitative and quantitative approaches
11. presenting information, developing an argument and drawing a conclusion, and using scientific, technical and mathematical language, conventions and symbols and ICT tools

### **Applications and implications of science**

12. the use of contemporary science and technological developments and their benefits, drawbacks and risks
13. how and why decisions about science and technology are made, including those that raise ethical issues, and about the social, economic and environmental effects of such decisions
14. how uncertainties in scientific knowledge and scientific ideas change over time and the role of the scientific community in validating these changes.

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## Mathematical skills

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Students should be able to:

1. understand number size and scale and the quantitative relationship between units
2. understand when and how to use estimation
3. carry out calculations involving  $+$ ,  $-$ ,  $\times$ ,  $\div$ , either singly or in combination, decimals, fractions, percentages and positive whole number powers
4. provide answers to calculations to an appropriate number of significant figures
5. understand and use the symbols  $=$ ,  $<$ ,  $>$ ,  $\sim$
6. understand and use direct proportion and simple ratios
7. calculate arithmetic means
8. understand and use common measures and simple compound measures such as speed
9. plot and draw graphs (line graphs, bar charts, pie charts, scatter graphs, histograms) selecting appropriate scales for the axes
10. substitute numerical values into simple formulae and equations using appropriate units
11. translate information between graphical and numeric form
12. extract and interpret information from charts, graphs and tables
13. understand the idea of probability
14. calculate area, perimeters and volumes of simple shapes

In addition, higher tier students should be able to:

15. interpret, order and calculate with numbers written in standard form
16. carry out calculations involving negative powers (only  $-1$  for rate)
17. change the subject of an equation
18. understand and use inverse proportion
19. understand and use percentiles and deciles.

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## List of unit contents

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### **Unit B3: Using biology**

Topic 1 Control systems

Topic 2 Behaviour

Topic 3 Biotechnology

### **Unit C: Chemistry in action**

Topic 1 Qualitative analysis

Topic 2 Quantitative analysis

Topic 3 Electrolytic Processes

Topic 4 Gases, equilibria and ammonia

Topic 5 Organic chemistry

### **Unit P3: Applications of physics**

Topic 1 Radiation in treatment and medicine

Topic 2 X-rays and ECGs

Topic 3 Production, uses and risks of ionising radiation from radioactive sources

Topic 4 Motion of particles

Topic 5 Kinetic theory and gases

### **Unit FASCA: Further Additional Science controlled assessment**



## Unit B3: Using biology

### Overview

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#### Content and How Science Works overview

In Unit B3 students study three topics that give them the opportunity to explore some areas of biology in more depth. The aim is to engender an interest in biology that makes them want to pursue the subject further or simply enjoy finding out more about themselves, other organisms and the applications of biology in the world in which they live.

Practical work throughout the unit will give students opportunities to plan and carry out investigations, to devise their own models and evaluate them, to assess and manage risks, to trial their plans and consider how the quality of their data might be improved. It also enables them to analyse data, to draw conclusions providing evidence to support their conclusions, and evaluate to what degree the conclusion supports the hypothesis.

Throughout the unit, students will have the opportunity to improve and demonstrate mathematical skills, including understanding and using direct proportion and simple ratios, calculating arithmetic means, plotting and drawing graphs (line graphs, bar charts, pie charts, scatter graphs, histograms) selecting appropriate scales for the axes, translating information between graphical and numeric form, extracting and interpreting information from charts, graphs and tables and understanding the idea of probability.

There are several opportunities to investigate the way scientists collect data, such as in the screening of plants for medical properties, and to see how this data is used to produce advances in science, such as in medical treatment. Further research on these advances highlights drawbacks and risks as well as advantages, and these aspects will be studied in relation to the use of dialysis, contraception and fertility treatments. With many treatments decisions need to be made about the social, economic and environmental effects, and some of these will be explored in the context of immunisation programmes.

Students are always fascinated by the complex functions of the human body. Topic 1 enables them to study systems and processes with which they are largely unfamiliar, for example the structure and function of the kidney, and hormonal control of the menstrual cycle. A study of sex-linked disorders and the principles of immunisation add to the variety of this topic.

The way scientific ideas change over time, and the role of the scientific community in validating those changes, will be considered when studying the role of Jenner in the development of immunisation.

In Topic 2 students will study different types of behaviour, such as courtship and conditioning. Methods of communication within the animal kingdom are also areas of great interest and the work of ethologists such as Tinbergen and Fossey is covered. Different types of evidence for human evolution are looked at in some depth in the final

part of Topic 2.

The study of animal and plant behaviour will provide opportunities to see how scientists gather data and use it to construct theories that can be scientifically tested, and then to see how these theories are applied to explain further observations. The continuing development of scientific knowledge, and the fact that science cannot answer all questions, will be explored in the studies of animal behaviour and human migration.

The focus of Topic 3 is on biotechnology and its applications, covering up-to-date issues such as the use of enzyme technology in the manufacture of vegetarian cheese, sweets and biological washing powders. Ethical issues are considered with respect to the genetic modification of crop plants, for example to confer herbicide resistance and insect resistance.

## **Assessment overview**

This unit is externally assessed, through a one hour, 60 mark, tiered written examination, containing six questions.

The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.



### Practical investigations in this unit

Within this unit, students will develop an understanding of the process of scientific investigations, including that investigations:

- use hypotheses which are tested
- require assessment and management of risks
- require the collection, presentation, analysis and interpretation of primary and secondary evidence including the use of appropriate technology
- should include a review of methodology to assess fitness for purpose
- should include a review of hypotheses in the light of outcomes.

The following specification points are practical investigations which exemplify the scientific process and may appear in the written examination for this unit:

- 1.28 *Investigate the conditions affecting growth of micro-organisms (using resazurin dye)*
- 2.8 *Investigate animal behaviour using choice chambers*
- 3.4 *Investigate the effect of factors on the growth of yeast, including pH*
- 3.9 *Investigate the effect of different factors on yogurt making*
- 3.11 *Investigate the use of immobilised lactase to produce lactose-free milk*
- 3.12 *Investigate the use of enzymes in food production*

The following are further suggestions for practical work within this unit:

- *Investigate the importance of photoperiodicity in plants*
- *Investigate the behaviour of animals rearing their young, using video technology*
- *Investigate different behaviours exhibited by animals*
- *Investigate how animals use a variety of types of signals to communicate*
- *Investigate the use of chymosin in the manufacture of vegetarian cheese*
- *Investigate the use of invertase (sucrase) produced by *Saccharomyces cerevisiae* (yeast) in the manufacture of sweets*
- *Investigate the use of enzymes in washing powders*

The controlled assessment task (CAT) for the GCSE in Further Additional Science will be taken from any of these practical investigations (specification points and further suggested practical work). This task will change every year, so future CATs will be chosen from this list.

## Detailed unit content

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In this specification bold text refers to higher tier only content. Italic text refers to practical investigations, which students are required to demonstrate an understanding of.

### Topic 1

#### Control systems

- 1.1 Demonstrate an understanding that cell metabolism leads to the build-up of waste products in the blood, including carbon dioxide and urea
- 1.2 Recall that urea is produced from the breakdown of excess amino acids in the liver and is removed by the kidneys
- 1.3 Describe the structure of the urinary system, including:
  - a renal artery and vein
  - b kidneys
  - c ureters
  - d bladder
  - e urethra
- 1.4 Describe possible treatments for kidney failure, including kidney dialysis and organ donation
- 1.5 Describe the structure of a nephron, including:
  - a glomerulus and Bowman's capsule
  - b convoluted tubules
  - c loop of Henlé
  - d collecting duct
- 1.6 Explain how the structure of the nephron is related to its function in filtering the blood and forming urine (osmoregulation), including:
  - a filtration in the glomerulus and Bowman's capsule
  - b selective reabsorption of glucose
  - c reabsorption of water (osmoregulation)
  - d removal of excess water in urine
- 1.7 **Demonstrate an understanding of the role of ADH (produced by the pituitary gland) in regulating the water content of the blood**
- 1.8 **Demonstrate an understanding of how ADH production is controlled by a negative feedback mechanism**
- 1.9 Recall that the menstrual cycle is controlled by the hormones oestrogen and progesterone
- 1.10 Describe the stages of the menstrual cycle including menstruation, uterus lining thickening and ovulation

- 1.11 Explain why the uterus lining is maintained if fertilisation occurs
- 1.12 **Demonstrate an understanding of how oestrogen, progesterone, FSH and LH control the menstrual cycle, including:**
  - a **FSH stimulates maturation of follicles, which stimulates oestrogen production**
  - b **oestrogen is responsible for repair of the uterus wall**
  - c **high levels of oestrogen stimulate a surge in LH, which triggers ovulation**
  - d **corpus luteum secretes progesterone, which maintains the lining of the uterus**
  - e **progesterone inhibits FSH and LH production**
  - f **during pregnancy, progesterone levels remain high**
  - g **menstruation is triggered by a drop in oestrogen and progesterone levels**
  - h **low progesterone levels allow an increase in FSH levels**
- 1.13 **Demonstrate an understanding of how the menstrual cycle is controlled by a negative feedback mechanism**
- 1.14 Explain how the structure of an egg is adapted to its function:
  - a cytoplasm to provide nutrients
  - b haploid nucleus containing one set of the genetic material
  - c immediately after fertilisation the cell membrane around the egg changes to block entry of other sperm
- 1.15 Explain how the structure of a sperm cell is adapted to its function, including:
  - a acrosome containing enzymes
  - b haploid nucleus containing one set of the genetic material
  - c middle section containing mitochondria
  - d tail for motility
- 1.16 Demonstrate an understanding of the advantages and disadvantages of infertility treatments, including:
  - a donation of eggs
  - b *in vitro* fertilisation (IVF)
  - c use of surrogate mothers
  - d use of hormones
- 1.17 Recall that the sex of a person is controlled by one pair of chromosomes, XX in a female and XY in a male
- 1.18 Explain how the sex of offspring is determined at fertilisation, using a genetic diagram

- 1.19 Explain (using probabilities, ratios and percentages) how sex-linked genetic disorders are inherited, including:
  - a haemophilia
  - b colour blindness
- 1.20 Describe Edward Jenner's contribution to the development of vaccines
- 1.21 Explain the process of immunisation, including:
  - a harmless pathogen or antigenic material introduced
  - b the antigens trigger an immune response which causes the production of antibodies
  - c the antigens also trigger production of memory lymphocytes
- 1.22 Demonstrate an understanding of the advantages and risks associated with immunisation
- 1.23 **Describe the role of memory lymphocytes in secondary responses to antigen; interpret data showing variation in blood antibody levels in response to first and subsequent infections**
- 1.24 **Describe the production of monoclonal antibodies, including:**
  - a **use of B lymphocytes which produce desired antibodies but do not divide**
  - b **production of hybridoma cells**
  - c **hybridoma cells produce antibodies and they divide**
- 1.25 **Demonstrate an understanding of the use of monoclonal antibodies, including:**
  - a **in pregnancy testing**
  - b **in diagnosis including locating the position of blood clots and cancer cells and in treatment of diseases including cancer**
  - c **the advantages of using monoclonal antibodies to target specific cells compared to drug and radiotherapy treatments**
- 1.26 Describe how the exponential growth of a population of bacteria can lead to rapid development of an infection
- 1.27 Demonstrate an understanding of Louis Pasteur's contribution to the development of aseptic techniques
- 1.28 *Investigate the conditions affecting growth of micro-organisms (using resazurin dye)*
- 1.29 Demonstrate an understanding that plants defend themselves against attack from pests and pathogens by producing chemicals, some of which can be used to treat human diseases, disorders or relieve symptoms
- 1.30 Demonstrate an understanding of the impact that attack by pests and pathogens on plants has on human food supply

- 1.31 Explain the importance of photoperiodicity in plants, including
  - a plant germination
  - b growth
  - c reproduction
- 1.32 Demonstrate an understanding of circadian rhythms in living organisms

## Topic 2

### Behaviour

- 2.1 Describe that sexual reproduction requires the finding and selection of a suitable mate, and can involve courtship behaviours that advertise an individual's quality
- 2.2 Describe how animals have different mating strategies, including:
  - a a mate for life
  - b several mates over a lifetime
  - c a mate for a breeding season
  - d several mates over one breeding season
- 2.3 Describe that some animals, in particular birds and mammals, have developed special behaviours for rearing their young
- 2.4 Demonstrate an understanding of why parental care can be a successful evolutionary strategy, including:
  - a increased chance of survival of offspring
  - b increased chance of parental genes being passed on by the offspring
- 2.5 Explain how, within the animal kingdom, parental care may involve risks to the parents
- 2.6 Describe the different behaviours exhibited by animals, including:
  - a innate behaviour
  - b imprinting
  - c habituation
  - d classical conditioning
  - e operant conditioning
- 2.7 Explain how humans can make use of conditioning when training captive animals for specific purposes, including:
  - a sniffer dogs
  - b police horses
  - c dolphins
- 2.8 *Investigate animal behaviour using choice chambers*

- 2.9 Describe how some animal behaviour requires communication (vapour)
- 2.10 Explain how animals use a variety of types of signals to communicate, including:
  - a sound signals
  - b chemical signals (pheromones)
  - c visual signals (gestures, body language, facial expression)
- 2.11 Describe how plants can communicate using chemicals, including:
  - a with animals (particularly insects)
  - b with other plants
- 2.12 Demonstrate an understanding of the work of ethologists, including:
  - a Tinbergen, innate behaviour in gulls
  - b Lorenz, imprinting in geese
  - c Fossey, social behaviour in gorillas
  - d Goodall, social behaviour in chimpanzees
- 2.13 **Demonstrate an understanding of how plants and animals have co-evolved, including:**
  - a **flower structure and insect behaviour in pollination**
  - b **plant defence and animal metabolism**
- 2.14 Describe the evidence for human evolution, based on fossils, including:
  - a Ardi from 4.4 million years ago
  - b Lucy from 3.2 million years ago
  - c Leakey's discovery of fossils from 1.6 million years ago
- 2.15 Describe the evidence for human evolution based on stone tools, including:
  - a the development of stone tools over time
  - b how these can be dated from their environment
- 2.16 **Describe why mitochondrial DNA provides evidence for the African Eve theory for non-Africans, including:**
  - a **its inheritance down the female line**
  - b **its high mutation rate**
- 2.17 **Demonstrate an understanding of why mitochondrial DNA is more useful than nuclear DNA for tracking human migration and evolution, including:**
  - a **mitochondrial DNA is less likely to have degraded over time**
  - b **mitochondrial DNA is more abundant**
- 2.18 Demonstrate an understanding of the impact of climate change on human behaviour, including:

- a the effect of the Ice Age
- b human migration

### Topic 3

#### Biotechnology

- 3.1 Describe biotechnology as the alteration of natural biomolecules using science and engineering to provide goods and services
- 3.2 Describe a fermenter as a vessel used to cultivate micro-organisms for the production of biomolecules on a large scale
- 3.3 Explain the need to supply suitable conditions in fermenters, and the effect they have on growth rates, including:
  - a aseptic precautions
  - b nutrients
  - c optimum temperature
  - d pH
  - e oxygenation
  - f agitation
- 3.4 *Investigate the effect of factors on the growth of yeast, including pH*
- 3.5 Explain the advantages of using micro-organisms for food production, including:
  - a rapid population growth
  - b ease of manipulation
  - c production independent of climate
  - d use of waste products from other industrial processes
- 3.6 Describe how mycoprotein is manufactured, including the role of the fungus *Fusarium sp.*
- 3.7 Explain the advantages of using mycoprotein as a food source
- 3.8 Describe how bacteria are used in the production of yogurt from milk by the conversion of lactose to lactic acid
- 3.9 *Investigate the effect of different factors on yogurt making*
- 3.10 Describe the use of enzyme technology including:
  - a chymosin, produced by genetically modified micro-organisms, used in the manufacture of vegetarian cheese
  - b invertase (sucrase) produced by *Saccharomyces cerevisiae* (yeast), used in the manufacture of sweets
  - c enzymes used in washing powders



- 3.11 *Investigate the use of immobilised lactase to produce lactose-free milk*
- 3.12 *Investigate the use of enzymes in food production*
- 3.13 **Explain recombinant DNA technology using insulin as an example, including:**
  - a **restriction enzymes**
  - b **ligase**
  - c **sticky ends**
- 3.14 Demonstrate an understanding of the impact of human population growth on global food security
- 3.15 Explain how *Agrobacterium tumefaciens* is used as a vector in creating transgenic plants
- 3.16 **Demonstrate an understanding of the advantages and disadvantages of introducing genes for insect resistance from *Bacillus thuringiensis* into crop plants**
- 3.17 Demonstrate an understanding of the costs and benefits of genetic modification of crop plants in the context of developed and developing countries, including the introduction of flavonoids in the purple tomato
- 3.18 Explain how increased food production for humans includes:
  - a conventional plant breeding programmes
  - b pest management strategies
  - c genetic modification
- 3.19 Demonstrate an understanding of the advantages and disadvantages of replacing fossil fuels with biofuels, including the facts that biofuels are renewable and that their production uses carbon dioxide but that growing the crops to make them requires land and may affect the availability of land for growing food

## Unit C3: Chemistry in action

### Overview

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#### Content and How Science Works overview

One of the attractive features of chemistry is that a knowledge and understanding of the basic ideas reduces the amount of learning required and provides the satisfaction of making successful predictions because the knowledge and understanding can be applied in a wide variety of ways in the laboratory and in industry.

The purpose of this unit is to provide students with opportunities to apply what they have learnt in C1 and C2. This consolidates their knowledge and understanding before commencing an AS / A level course, or gives them the satisfaction of feeling that they have achieved something worthwhile in their science GCSEs. They will realise that they can study and understand qualitative and quantitative inorganic analysis, electrolysis, equilibrium and organic chemistry, seeing the importance and relevance of what they have learned for industrial as well as for laboratory processes.

Practical work in this unit will give students opportunities to plan practical ways to answer scientific questions; 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; draw evidence-based conclusions; and evaluate methods of data collection and the quality of the resulting data.

Work on electrolysis, reversible reactions and dynamic equilibrium, and the structures of molecules in homologous series, provides students with opportunities to use models to explain ideas and processes, and to communicate scientific information using scientific conventions and symbols.

Students will have the opportunity to work quantitatively when carrying out mole calculations and working with volumes of gases, and when writing balanced chemical equations and half equations.

Work on ion tests and the quantitative testing of water allows students to consider the role chemistry plays in providing safe drinking water. Studying the uses of sodium, the purification of copper, the use of electroplating, the manufacture of fertiliser and the production of ethanol, vinegar, esters and soap shows students the importance of the chemical industry in providing useful materials.

Students have the opportunity to consider the advantages, disadvantages and risks of the applications of some of the substances studied, including problems caused by hard water, the over-use of fertilisers, the social effects of alcoholic drinks and the uses of esters.

They will consider the economic factors involved in choosing reaction conditions for the Haber process and in choosing the method used to produce ethanol. They will also consider issues of sustainability, such as the need to recycle some materials.

In Topic 1, building on their work in C2, candidates will extend their knowledge of tests for ions to enable them to identify unknown salts and will see how qualitative analysis has relevance to chemists working in fields such as forensic science.

In Topic 2 students will learn that amounts of substances are expressed in moles and, having carried out titrations, will do calculations to determine concentrations of dissolved substances. They will also learn how to prepare soluble salts and understand that using an excess of a reactant is practically convenient but that simple titration has to be used when the reactant is soluble. They will also see how the presence of some dissolved salts can cause water to be hard and to appreciate the problems this raises.

Having learnt that electrolysis results in the decomposition of aqueous solutions of salts, students can use their knowledge of ions in Topic 3 to understand and make predictions about such processes and to write half equations for the reactions occurring at the electrodes. Purification of copper and electroplating demonstrate the relevance, in industry, of what they have learnt.

In Topic 4 the introduction of molar volume and of Avogadro's law enables students to do quantitative work related to volumes of gases. They are then able to consider dynamic equilibria and how changing conditions affects equilibrium yield and rate of attainment of equilibrium. This will lead them to focus on the Haber process and the manufacture of fertilisers.

In Topic 5 students will widen their knowledge of organic chemistry and begin to understand the beauty of organic chemistry, where a little knowledge can go a long way. They will study ethanol, ethanoic acid and ethyl ethanoate leading, through the concept of homologous series, to the series of alcohols, carboxylic acids and esters. An appreciation that oils and fats are esters leads to the production of soaps.

## Assessment overview

This unit is externally assessed, through a one hour, 60 mark tiered written examination, containing six questions.

The examination will contain a mixture of questions styles, including objective questions; short answer questions and extended writing questions.

## Practical investigations in this unit

Within this unit, students will develop understanding of the process of scientific investigations, including that investigations:

- use hypotheses which are tested
- require assessment and management of risks

- require the collection, presentation, analysis and interpretation of primary and secondary evidence including the use of appropriate technology
- should include a review of methodology to assess fitness for purpose
- should include a review of hypotheses in the light of outcomes.

The following specification points are practical investigations which exemplify the scientific process and may appear in the written examination for this unit:

- 1.4 *Identify the ions in unknown salts, using the tests above and in unit C2, specification point 2.15*
- 2.6 *Evaporate a solution to dryness to determine the mass of solute in a given mass of solution*
- 2.14 *Carry out an acid-base titration to prepare a salt from a soluble base*
- 3.8 *Electrolyse sodium chloride solution*
- 3.12 *Investigate the mass changes at the electrodes during the electrolysis of copper sulfate solution using copper electrodes*
- 5.2 *Prepare a solution of ethanol by fermentation*

The following are further suggestions for practical work within this unit:

- *Investigate the properties of a group of elements eg Group 2*
- *Describe an experiment to test the hardness of samples of water by shaking the sample with soap solution*
- *Investigate methods for removing hardness in water*
- *Carry out titrations reaction to find an unknown concentration of an acid or alkali in solution*
- *Investigate the migration of ions in eg potassium manganate (VII) solution*
- *Investigate the products of electrolysis of solutions of salts*
- *Electroplate a metal object*
- *Determine the volume of one mole of hydrogen gas by using the reaction of magnesium with hydrochloric acid*
- *Determine the molar volume by measuring the volume and mass of a gas using a heavier gas (eg carbon dioxide)*
- *Investigate simple reversible reactions, such as the decomposition of ammonium chloride*
- *Dehydration of ethanol*
- *Oxidation of ethanol*
- *Reactions of ethanoic acid*
- *Describe an experiment to prepare an ester on a test tube scale*

- *Manufacture of soap*

The Controlled Assessment Task (CAT) for the GCSE in Further Additional Science will be taken from any of these practicals (specification points and further suggested practicals). This task will change every year, so future CATs will be chosen from this list.

### Detailed unit content

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In this specification bold text refers to higher tier only content. Italic text refers to practical investigations, which students are required to demonstrate an understanding of.

#### Throughout the unit

- 0.1 Recall the formulae of elements and simple compounds in the unit
- 0.2 Represent chemical reactions by word equations and simple balanced equations
- 0.3 Write balanced chemical equations including the use of state symbols (s), (l), (g) and (aq) for a wide range of reactions in this unit
- 0.4 Write balanced ionic equations for a wide range of reactions in this unit and those in unit C2, specification point 2.15
- 0.5 Assess practical work for risks and suggest suitable precautions for a range of practical scenarios for reactions in this unit
- 0.6 Demonstrate an understanding that hazard symbols used on containers:
  - a indicate the dangers associated with the contents
  - b inform people about safe-working procedures with these substances in the laboratory

### Topic 1

#### Qualitative analysis

- 1.1 Demonstrate an understanding that analysis may be qualitative or quantitative
- 1.2 Explain why the test for any ion must be unique
- 1.3 Describe tests to show the presence of the following ions in solids or solutions as appropriate:
  - a  $\text{Al}^{3+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$  using sodium hydroxide solution
  - b  $\text{NH}_4^+$  using sodium hydroxide solution, warming and testing for the ammonia gas produced
  - c  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$  using dilute nitric acid and silver nitrate solution
- 1.4 *Identify the ions in unknown salts, using the tests above and in unit C2, specification point 2.15*
- 1.5 Demonstrate an understanding that these tests form the basis for testing by chemists:
  - a working in the water industry to check the purity of drinking water
  - b for the presence of substances in the blood

## Topic 2

## Quantitative analysis

- 2.1 Calculate the concentration of solutions in  $\text{g dm}^{-3}$
- 2.2 Demonstrate an understanding that some areas of the country have dissolved calcium or magnesium ions in their tap water and that the presence of these ions makes the water hard
- 2.3 Describe problems caused by hard water, including:
  - a it does not easily form a lather with soap
  - b it reacts with soap to form a precipitate ("scum"), which causes soap to be wasted
- 2.4 Describe hard water as either temporary or permanent; and describe how boiling removes temporary hardness but not permanent hardness
- 2.5 Explain how hard water can be softened by removing the dissolved calcium and/or magnesium ions and that this can be done by:
  - a boiling (for temporary hard water only)
  - b using an ion exchange resin
- 2.6 *Evaporate a solution to dryness to determine the mass of solute in a given mass of solution*
- 2.7 **Demonstrate an understanding that the amount of a substance can be measured in grams, numbers of particles or number of moles of particles**
- 2.8 **Convert masses of substances into moles of particles of the substance and vice versa**
- 2.9 **Convert concentration in  $\text{g dm}^{-3}$  into  $\text{mol dm}^{-3}$  and vice versa**
- 2.10 Demonstrate an understanding that if soluble salts are prepared from an acid and an insoluble reactant:
  - a excess of the reactant can be added to ensure that all the acid is used up
  - b the excess reactant can be removed by filtration
  - c the solution remaining is only salt and water
- 2.11 Demonstrate an understanding that if soluble salts are prepared from an acid and a soluble reactant:
  - a titration must be used to determine the exact amount of the soluble reactant that reacts with an acid
  - b the acid and the soluble reactant can then be mixed in the correct proportions
  - c the solution remaining after reaction is only salt and water
- 2.12 Describe an acid-base titration as a neutralisation reaction where hydrogen ions ( $\text{H}^+$ ) from the acid react with hydroxide ions ( $\text{OH}^-$ ) from the base



- 2.13 Describe how to carry out simple acid-base titrations using burette, pipette and suitable acid-base indicators
- 2.14 *Carry out an acid-base titration to prepare a salt from a soluble base*
- 2.15 **Carry out simple calculations using the results of titrations to calculate an unknown concentration of a solution or an unknown volume of solution required.**

### Topic 3

#### Electrolytic processes

- 3.1 Explain that electrolytes are ionic substances in the molten state or dissolved in water
- 3.2 Describe the movement of ions during electrolysis, such that
  - a positively charged cations migrate to the negatively charged cathode
  - b negatively charged anions migrate to the positively charged anode
- 3.3 Demonstrate an understanding that oxidation can involve the loss of electrons and reduction can involve the gain of electrons
- 3.4 Demonstrate an understanding that reduction occurs at the cathode and that oxidation occurs at the anode in electrolysis reactions
- 3.5 **Write half equations for reactions occurring at the anode and cathode in examples of electrolysis reactions in this unit**
- 3.6 Describe the manufacture of sodium by the electrolysis of molten sodium chloride (details of the electrolytic cell are not required)
- 3.7 Recall that sodium can be used in street lamps and as a coolant in some nuclear reactors
- 3.8 *Electrolyse sodium chloride solution*
- 3.9 Explain the formation of the products in the electrolysis of sodium chloride solution
- 3.10 Describe how the electrolysis of aqueous solutions can give products from ions in water, rather than from ions of the dissolved solid
- 3.11 Explain the formation of the products in the electrolysis, using inert electrodes, of some electrolytes, including:
  - a copper chloride solution
  - b copper sulfate solution
  - c sodium sulfate solution
  - d molten lead bromide
- 3.12 *Investigate the mass changes at the electrodes during the electrolysis of copper sulfate solution using copper electrodes*

- 3.13 Describe the purification of copper by electrolysis using a pure copper cathode and an impure copper anode
- 3.14 Explain how electroplating can be used to improve the appearance and/or the resistance to corrosion of metal objects

## Topic 4

### Gases, equilibria and ammonia

- 4.1 **Demonstrate an understanding that one mole of any gas occupies 24 dm<sup>3</sup> at room temperature and atmospheric pressure and that this is known as the molar volume of the gas**
- 4.2 **Use molar volume and balanced equations in calculations involving the masses of solids and volumes of gases**
- 4.3 **Use Avogadro's law to calculate volumes of gases involved in gaseous reactions, given the relevant equations**
- 4.4 Recall that nitrogenous fertilisers are manufactured from ammonia and that they promote plant growth
- 4.5 Demonstrate an understanding of the environmental consequences of the over-use of fertilisers, including excessive plant growth in rivers and lakes
- 4.6 Recall that chemical reactions are reversible and that the Haber process uses a reversible reaction between nitrogen (extracted from the air) and hydrogen (obtained from natural gas) to form ammonia
- 4.7 **Demonstrate an understanding of the concept of dynamic equilibrium**
- 4.8 **Explain how the position of a dynamic equilibrium is affected by changes in:**
  - a **temperature**
  - b **pressure**
- 4.9 **Demonstrate an understanding of the consequential effects of these changes on the rate of attainment of equilibrium and of the need to use a catalyst**
- 4.10 **Describe how, in industrial reactions such as the Haber process, the temperature, pressure and catalyst used produce an acceptable yield in an acceptable time**

## Topic 5

### Organic chemistry

- 5.1 Describe how ethanol is produced during the fermentation of carbohydrates, including:
  - a that the fermentation mixture is kept warm and under anaerobic conditions
  - b that yeast provides an enzyme for this reaction

- 5.2 *Prepare a solution of ethanol by fermentation*
- 5.3 Recall that different percentages of ethanol are present in various drinks
- 5.4 Demonstrate an understanding of the social issues and possible harmful effects of ethanol in alcoholic drinks
- 5.5 Explain how to obtain a concentrated solution of ethanol by fractional distillation of the fermentation mixture
- 5.6 **Recall how ethanol can also be manufactured by reacting ethene (from cracking of crude oil fractions) with steam**
- 5.7 **Evaluate the factors which are relevant to the choice of method used in the manufacture of ethanol, including:**
  - a **the relative availability of sugar cane or sugar beet and crude oil**
  - b **the quality of the final product and whether it needs further processing**
- 5.8 **Recall that the dehydration of ethanol results in the formation of ethene**
- 5.9 Define homologous series as a series of compounds which:
  - a have the same general formula
  - b show a gradual variation in physical properties as exemplified by their boiling points
  - c have similar chemical properties
- 5.10 Recall the names, formulae and structures of members of the following homologous series:
  - a alkanes, up to 4 carbons atoms per molecule
  - b alkenes, up to 3 carbons atoms per molecule
  - c **alcohols, up to 3 carbons atoms per molecule**
  - d **carboxylic acids, up to 3 carbon atoms per molecule**(no treatment of isomers is required in any of these series)
- 5.11 Demonstrate an understanding that ethanol can be oxidised to form ethanoic acid and that this reaction occurs in open bottles of wine and in the production of ethanoic acid in vinegar
- 5.12 Describe the use of vinegar as a flavouring and as a preservative
- 5.13 Demonstrate an understanding that ethanoic acid is a typical acid, including:
  - a its reaction with metals
  - b its reaction with bases and carbonates to form salts (ethanoates)
  - c its typical effect on indicators
- 5.14 Describe the reaction of ethanol with ethanoic acid to produce an ester, ethyl ethanoate and water **including writing an equation for this reaction using molecular and structural formulae**

- 5.15 Describe uses of:
- a esters as flavourings and perfumes, as they are pleasant-smelling
  - b polyesters as fibres to make fabric and as plastics for making bottles (no consideration of the formation of polyester is required)
- 5.16 Demonstrate an understanding that polyesters can be recycled to form fleece that is used to make clothing
- 5.17 Recall that oils and fats are esters
- 5.18 Describe the breaking down of oils and fats, by boiling with concentrated alkali solution, to produce soaps, which are sodium or potassium salts of long carbon chain carboxylic acids
- 5.19 **Demonstrate an understanding of how a soap removes dirt or grease, including**
- a **that part of the soap anion is hydrophobic and dissolves in dirt or grease**
  - b **that the other part is hydrophilic and dissolves in water**
- 5.20 **Demonstrate an understanding that liquid oils can be converted to solid fats by catalytic hydrogenation which removes the C=C unsaturation and that this process is used to manufacture margarine**
- b practical losses during the preparation
  - c competing, unwanted reactions

# Unit P3: Application of physics

## Overview

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### Content and How Science Works overview

This highly engaging unit builds on the knowledge gained in units P1 and P2 by introducing students to medical physics. Students will learn how physics principles are vital in modern medicine in the way in which they are applied to diagnosis, treatment and storage of medicines.

Practical work in this unit will give students opportunities to plan practical ways to answer scientific questions; 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; draw evidence-based conclusions; and evaluate methods of data collection and the quality of the resulting data.

Students will explain ideas and processes using models while studying radiation, radioactive decay, subatomic structure, momentum and kinetic theory. Work on the intensity of radiation, lenses, momentum, kinetic energy, frequency and gases will provide students with opportunities to work quantitatively. They will have opportunities to communicate scientific information using scientific and mathematical conventions and symbols during work on ray diagrams and vision, and when constructing nuclear equations.

Students will consider the role that physics and physicists play in our lives through the study of laser and other treatments for correcting vision, the use of X-rays in medicine, ECGs and pacemakers, and the uses of radioactive materials. They will consider advantages, disadvantages and risks of using radioactive materials, and consider how decisions about their use are made. They will look at how international collaboration is necessary for the building of particle accelerators and how these can lead to new discoveries about the world around us.

In Topic 1 students will learn about the use of radiation and other waves in medical treatment and diagnosis. Students will apply their understanding of lenses to treatments for long and short sightedness.

In Topic 2 students will learn about the production of X-rays and then discuss the risks and advantages of using X-rays for treatment and diagnosis. A brief study of the use of an electrocardiogram (ECG) will enable students to develop a simple understanding of the use of a pacemaker to regulate heart action.

In Topic 3 students will discuss the ethical and social issues relating to the use of radioactive techniques in medical physics. Students will learn in detail about the decay of radio isotopes and the use of beta decay. They will relate their knowledge to medical treatments and diagnosis and the dangers of using radiation.

In Topic 4 students will investigate circular motion, momentum and conservation of energy. Students will develop an understanding of particle accelerators and their use in medical physics and wider research.

In Topic 5 students will learn simple kinetic theory and the gas laws. They will learn the general gas equation and how to apply this equation to, for example, bottled gases in medicine.

## Assessment overview

This unit is externally assessed, through a one hour, 60 mark, tiered written examination, containing six questions.

The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.

## Practical investigations in this unit

Within this unit, students will develop understanding of the process of scientific investigations, including that investigations:

- use hypotheses which are tested
- require assessment and management of risks
- require the collection, presentation, analysis and interpretation of primary and secondary evidence including the use of appropriate technology
- should include review of methodology to assess fitness for purpose
- should include a review of hypotheses in the light of outcomes.

The following specification points are practical investigations that exemplify the scientific process and may appear in the written examination for this unit:

- 1.8 *Investigate variations of image characteristics with objects at different distances from a converging lens*
- 1.18 *Investigate the critical angle for perspex/air or glass/air or water/air boundaries*
- 1.19 *Investigate TIR between different media*
- 4.12 *Investigate factors affecting the height of rebound of bouncing balls*
- 5.7 *Investigate the temperature and volume relationship for a gas*
- 5.9 *Investigate the volume and pressure relationship for a gas*

The following are further suggestions for practical work within this unit:

- *Investigate the relationship between the intensity of radiation and the distance from the source*
- *Investigate the absorption of light by translucent materials in order to simulate X-rays' absorption*

- *Investigate conservation of energy and momentum during collisions using models to represent particles*
- *Investigate inelastic collisions with the two objects remaining together after the collision and also 'near' elastic collisions*
- *Investigate the temperature and pressure relationship for a gas*

The controlled assessment task (CAT) for the GCSE in Further Additional Science will be taken from any of these practical investigations (specification points and further suggested practical investigations). This task will change every year, so future CATs will be chosen from this list.

## Detailed unit content

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In this specification bold text refers to higher tier only content. Italic text refers to practical investigations, which students are required to demonstrate an understanding of.

### Throughout the unit

- 0.1 Use equations given in this unit, or in a given alternate form
- 0.2 **Use and rearrange equations given in this unit**
- 0.3 Demonstrate an understanding of which units are required in equations

## Topic 1

### Radiation in treatment and medicine

- 1.1 Demonstrate an understanding of the methods that medical physicists can employ to help doctors solve medical problems, including:
  - a CAT scans
  - b ultrasounds
  - c endoscopes
  - d ionising and non-ionising radiation
- 1.2 Use the word 'radiation' to describe any form of energy originating from a source, including both waves and particles
- 1.3 Demonstrate an understanding that the intensity of radiation will decrease with distance from a source and according to the nature of the medium through which it is travelling
- 1.4 **Use the equation:**  
**intensity = power of incident radiation / area**  

$$I = \frac{P}{A}$$
- 1.5 Describe the refraction of light by converging and diverging lenses
- 1.6 Relate the power of a lens to its shape
- 1.7 Use the equation:  
 power of lens (diopetre, D) = 1/focal length (metre, m)
- 1.8 *Investigate variations of image characteristics with objects at different distances from a converging lens*
- 1.9 **Use the lens equation:**  

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$
**(f = focal length (m), u = object distance (m), v = image distance (m))**  
**The use of the real is positive sign convention is preferred and will be used in the exam**
- 1.10 Identify the following features in a diagram of the eye – cornea, iris, pupil, lens, retina, ciliary muscles



- 1.11 Demonstrate an understanding that light is focused on the retina by the action of the lens and cornea
- 1.12 Recall that the average adult human eye has a near point at about 25 cm and a far point at infinity
- 1.13 Explain the symptoms and causes of short sight and long sight (students will not be expected to draw scaled ray diagrams, but may be expected to interpret them)
- 1.14 Compare and contrast treatments for short sight and long sight, including the use of:
  - a simple lenses
  - b contact lenses
  - c **laser correction**  
(combined lens equation is not required; students will not be expected to draw scaled ray diagrams, but may be expected to interpret them)
- 1.15 Explain, with the aid of ray diagrams, reflection, refraction and total internal reflection (TIR), including the law of reflection and critical angle
- 1.16 **Calculate critical angle using Snell's Law**
- 1.17 Explain refraction in terms of change of speed of radiation
- 1.18 *Investigate the critical angle for perspex/air or glass/air or water/air boundaries*
- 1.19 *Investigate TIR between different media*
- 1.20 Explain how TIR is used in optical fibres
- 1.21 Explain uses of optical fibres in endoscopes
- 1.22 Explain uses of ultrasound in diagnosis and treatment

## Topic 2

### X-rays and ECGs

- 2.1 Relate the ionisation by X-rays to their frequency and energy qualitatively ( $E = hf$  is not required)
- 2.2 Explain the key features of passing a current through an evacuated tube, including:
  - a thermionic emission of electrons from a heated filament
  - b potential difference between the cathode (filament) and the anode (metal target)
  - c why the vacuum is necessary
  - d possible production of X-rays by collision with a metal target
- 2.3 Explain why a beam of charged particles is equivalent to an electric current
- 2.4 **Use the equation:**  
**current (ampere, A) = number of particles per second (1/**

**second, 1/s) × charge on each particle (coulomb, C)**

$$I = N \times q$$

**2.5 Use the equation:**

**kinetic energy (joule, J) = electronic charge (coulomb, C)  
× accelerating potential difference (volt, V)**

$$KE = \frac{1}{2}mv^2 = e \times V$$

**2.6 Demonstrate an understanding of the inverse square law for electromagnetic radiation**

**2.7 Relate the absorption of X-rays to the thickness of the material through which they are travelling, quantitatively**

**2.8 Describe how X-rays are used in CAT scans and fluoroscopes**

**2.9 Demonstrate an understanding of the comparison of the risks and advantages of using X-rays for treatment and diagnosis**

**2.10 Explain how action potentials can be measured with an electrocardiogram (ECG) to monitor heart action**

**2.11 Relate the characteristic shape of a normal ECG to heart action**

**2.12 Use the equation:**

frequency (hertz, Hz) = 1/time period (second, s)

$$f = \frac{1}{T}$$

**2.13 Describe the use of a pacemaker to regulate the heart action**

**2.14 Describe the principles and use of pulse oximetry**

## Topic 3

### Production, uses and risks of ionising radiation from radioactive sources

**3.1 Evaluate the social and ethical issues relating to the use of radioactive techniques in medical physics**

**3.2 Describe the properties of alpha, beta, gamma, positron and neutron radiation**

**3.3 Recall the relative masses and relative electric charges of protons, neutrons, electrons and positrons**

**3.4 Recall that in an atom the number of protons equals the number of electrons**

**3.5 Describe the process of  $\beta^-$  decay (a neutron becomes a proton plus an electron)**

**3.6 Describe the process of  $\beta^+$  decay (a proton becomes a neutron plus a positron)**

**3.7 Explain the effects on the atomic (proton) number and mass (nucleon) number of radioactive decays ( $\alpha$ ,  $\beta$  and  $\gamma$  decay)**

**3.8 Use given data to balance nuclear equations**

**3.9 Describe the features of the  $N$ - $Z$  curve for stable isotopes**

- 3.10 **Identify isotopes as radioactive from their position relative to the stability curve**
- 3.11 **Recall that nuclei with high values of  $Z$  (above 82) usually undergo alpha decay**
- 3.12 **Recall that an isotope above the curve has too many neutrons to be stable and will undergo  $\beta^-$  decay**
- 3.13 **Recall that an isotope below the curve has too many protons to be stable and will undergo  $\beta^+$  decay**
- 3.14 **Recall that the proton and neutron each contain three particles called quarks**
- 3.15 **Describe the arrangement of up and down quarks in protons and neutrons**
- 3.16 **Use given data to explain the arrangement of up and down quarks in protons and neutrons in terms of charge and mass**
- 3.17 **Explain  $\beta^-$  decay as a process that involves a down quark changing into an up quark (a neutron becomes a proton and an electron)**
- 3.18 **Explain  $\beta^+$  decay as a process that involves an up quark changing into a down quark (a proton becomes a neutron and a positron)**
- 3.19 Recall that nuclei that have undergone radioactive decay often undergo nuclear rearrangement with a loss of energy as gamma radiation
- 3.20 Describe the dangers of ionising radiation in terms of tissue damage and possible mutations
- 3.21 Explain the precautions taken to ensure the safety of people exposed to radiation, including limiting the dose for patients and the risks to medical personnel
- 3.22 Compare and contrast the treatment of tumours using radiation applied internally or externally
- 3.23 Describe palliative care including the use of radiation in some instances
- 3.24 Explain some of the uses of radioactive substances in diagnosis of medical conditions, including PET scanners and tracers
- 3.25 Explain why isotopes used in PET scanners have to be produced nearby

## Topic 4

### Motion of particles

- 4.1 Discuss how instruments, including particle accelerators, can help scientists develop better explanations about the physical world
- 4.2 Discuss reasons for collaborative, international research into big scientific questions, including particle physics
- 4.3 Explain how for motion in a circle there must be a resultant force known as a centripetal force that acts towards the centre of the circle
- 4.4 Explain how particle accelerators called cyclotrons cause charged particles to move in a circular or spiral path, due to a magnetic field
- 4.5 Demonstrate an understanding that certain stable elements can be bombarded with proton radiation to change them into radioactive isotopes
- 4.6 Describe the use of particle accelerators (cyclotrons) to produce radioactive isotopes for medical purposes
- 4.7 Demonstrate an understanding that for inelastic collisions momentum is conserved but kinetic energy is not conserved
- 4.8 Demonstrate an understanding that for elastic collisions both momentum and kinetic energy are conserved
- 4.9 Analyse collisions in one dimension in terms of momentum and kinetic energy
- 4.10 **Carry out calculations using momentum conservation for a two-body collision (in one dimension only)**
- 4.11 **Carry out calculations using conservation of kinetic energy for a two-body elastic collision (in one dimension only)**
- 4.12 *Investigate factors affecting the height of rebound of bouncing balls*
- 4.13 Recall that gamma rays can be produced by the annihilation of an electron and a positron
- 4.14 Apply conservation of momentum and charge to positron electron annihilation
- 4.15 Apply the idea of conservation of mass energy for positron electron annihilation
  - a in a qualitative way (calculations involving  $E = mc^2$  will not be required)
  - b **in a quantitative way using the equation  $E = mc^2$**
- 4.16 Explain the use of radio isotopes in PET scanners to produce gamma rays

## Topic 5

### Kinetic theory and gases

- 5.1 Use a simple kinetic theory model to describe movement of particles in the three states of matter
- 5.2 Explain the pressure of a gas in terms of the motion of its particles
- 5.3 Describe the effect of changing the temperature of a gas on the speed of its particles
- 5.4 Describe the term absolute zero,  $-273^{\circ}\text{C}$ , in terms of the lack of movement of particles
- 5.5 Convert between the Kelvin and Celsius scales
- 5.6 Recall that the average kinetic energy of the particles in a gas is directly proportional to the Kelvin temperature of the gas
- 5.7 *Investigate the temperature and volume relationship for a gas*
- 5.8 Use the relationship:  
$$V_1 = \frac{V_2 T_1}{T_2}$$
to calculate volume for gases of fixed mass at constant pressure (rearranging not required)
- 5.9 *Investigate the volume and pressure relationship for a gas*
- 5.10 Use the relationship:  
$$V_1 P_1 = V_2 P_2$$
to calculate volume or pressure for gases of fixed mass at constant temperature
- 5.11 **Use the equation:**  
**initial pressure (pascal, Pa)  $\times$  initial volume (metre<sup>3</sup>, m<sup>3</sup>) / initial temperature (kelvin, K) = final pressure (pascal, Pa)  $\times$  final volume (metre<sup>3</sup>, m<sup>3</sup>) / final temperature (kelvin, K)**  
$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$
- 5.12 Apply an understanding of the equation in 5.11 to the use of bottled gases in medicine, including the need for a pressure above atmospheric and the calculation of the volume of gas released at atmospheric pressure



## Unit FASCA: Further Additional Science controlled assessment

### Overview

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#### Content overview

The controlled assessment is designed to enable students to engage with the scientific process through setting a hypothesis relevant to a given set of variables and then planning an investigation, observing recording and presenting outcomes and conclusions.

The student task will consist of three parts:

**Part A – Planning**

**Part B – Observations**

**Part C – Conclusions**

The tasks, provided by Edexcel, will relate to the following units in this specification:

B3 – Using biology

C3 – Chemistry in action

P3 – Application of physics

**Students must NOT submit a controlled assessment task for units B1, C1, P1, B2, C2, P2 for this qualification.**

The quality of written communication will be important in all reports produced as how students present, order and explain their work links directly to how well it is understood by the reader.

#### Assessment overview

- This unit is internally assessed under controlled conditions.
- There will be three tasks available each year - one task from B3, one task from C3, and one task from P3.
- Each task has a shelf life of one year.
- The tasks will be available to teachers one year in advance.
- Each task has three - parts Part A: Planning, Part B: Observations and Part C: Conclusions.
- The total number of marks available for the three parts is 50.
- Students must attempt all three parts of a task.
- If they attempt all tasks, then the best marks from Part A, B and C should be submitted for the unit.

## Detailed unit content

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### Delivery of the controlled assessment

#### Skills

Students should demonstrate the ability to carry out the following skills when completing a task:

- use a hypothesis and plan practical ways to test it including risk assessment
- manage risks when carrying out practical work
- collect, process, analyse and interpret primary and secondary evidence including the use of appropriate technology to draw evidence-based conclusions
- review methodology to assess fitness for purpose, and review the hypothesis in light of outcomes.

#### Parts of the controlled assessment tasks

##### Part A – Planning (20 marks)

Includes choosing equipment, hypothesis, controls needed for the task, evidence/observations and range, identification and management of risk.

##### Part B – Observations (6 marks)

Includes primary and secondary evidence collection and recording.

##### Part C – Conclusions (24 marks)

Includes processing and presentation of evidence, quality of evidence, conclusions based on evidence, evaluation of method, evaluation of conclusion.

#### Student support

Where students produce a plan which is unworkable or dangerous, it is permitted for teachers to provide students with a plan, provided it is clear that students will not receive Part A marks for this plan.

#### Levels of control

Internal assessment under controlled conditions has levels of control for task setting, task taking and task marking. These must be adhered to when students are completing their controlled assessment tasks.

##### Summary of levels of control

Area	Level of control
Part A – Planning	Limited
Part B – Observations	Limited
Part C – Conclusions	High

Candidates and teachers will be required to sign a declaration of authentication (see page 81) to indicate that rules have been adhered to.



### Task setting

#### High level of control

A high level of control means that tasks will be set by Edexcel and centres will choose from a list of tasks, from the other units in this qualification.

#### Which task can my students complete?

Candidates cannot submit marks from the same subject for Additional Science (ASCA) and Further Additional Science (FASCA). For example, if a candidate submits a Biology CAT for ASCA, they must submit either Chemistry or a Physics CAT for FASCA.

If a candidate submits part marks from different CATs in ASCA, they may not submit marks from the same subject for the same part in FASCA. For example, if they submit marks for their Part A from Chemistry for ASCA, they must submit a mark for Part A from either Biology or Physics in FASCA.

#### When will the tasks be available?

They will be available on the Edexcel website for teachers to download a year ahead of their first assessment opportunity. Teachers can view all the task sheets available before deciding which task the students will complete.

#### When should the tasks be made available to students?

The task sheets for this controlled assessment are confidential and must not be shown to students before they start the tasks. Task sheets should not be shown to students until the start of the task planning stage of the controlled assessment.

#### Do all my students have to do the same task?

It is acceptable for all the students in a class to complete the same task. However, the same task does not have to be chosen for all students and they can work on a mixture of different tasks from B3, C3 or P3.

The tasks will change every year, in accordance with the Ofqual regulations for GCSE Science. Teachers must take care when using these tasks to ensure that students are completing the correct task for a particular year. The front sheet of each task will show the dates for which it is valid.

**Task taking****a Research and data collection – limited level of control**

Research and data collection, including practical work, will be carried out under limited control. This means that students may work collaboratively when collecting data from practical activities.

Students may carry out any secondary research whilst not being directly supervised by a teacher, for example in a library or at home. The secondary research can include extracts from books and websites.

**b Analysis, conclusions and evaluation of findings – high level of control**

The analysis, conclusions and evaluation will be produced by students under high levels of control. This means that this part of the write-up must be carried out individually by the students, under the supervision of a teacher.

The production of the final report will usually take place over several lessons, so the students' materials must be collected in at the end of the lesson and handed back at the beginning of the next one. Students' final reports must be produced individually.

**Communication with students during the controlled assessment**

Feedback can be given to students during the controlled assessment, but this must be general rather than specific feedback. Teachers may give students general feedback on:

- the equipment chosen
- the controls for the task
- data to be collected or observations to be made
- risks involved with the task
- techniques for processing data/observations
- skills involved in the conclusions and evaluation.

Students should receive a copy of the assessment criteria so that they are aware of what they need to do to access the full range of marks.

**Suggested timings of each area**

The suggested timing for each part of the controlled assessment task is as follows:

Part A – Planning	1 hour
Part B – Observations	1 hour
Part C – Conclusions	1 hour
Total of 3 hours	

For this controlled assessment unit, it is expected that students should be given approximately 6 hours of time specifically on preparing for tasks. By using the practicals noted in the theory units, this can be achieved as part of your normal teaching.

### Task marking

#### Task marking – medium level of control

A medium level of control means that the marking of the tasks will be carried out by teachers and moderated by Edexcel.

### Marking procedure

Teachers should use the assessment criteria to mark the tasks and use the *Controlled Assessment Record Sheet* (Appendix 5) to record the marks. Edexcel will give Extension guidance of the application of the generic marking criteria in support documentation.

It is good practice for teachers to annotate student's work to show how the marks have been allocated for each section.

### Submitting marks

Students must attempt all three parts of any task they do.

Final marks for each section of the students' work should be recorded on the *Controlled Assessment Record Sheet* in Appendix 5.

They don't need to submit all marks from a task but can submit the best marks from any of the tasks they have attempted.

If a mark is submitted from a task, the student response to all three parts must be marked and retained by the centre for moderation.

Each CAT may be submitted for moderation in May.

### Health and safety

Students must observe safe practice when they are carrying out practical work. It is the responsibility of centres to carry out risk assessments for all practical work that they undertake with their students.

In this internal assessment teachers will have limited control when students are collecting their data, but it should be carried out under full supervision for health and safety reasons. The limited control means that students can work collaboratively to collect their data.

## Assessment criteria

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### Part A - Planning

Element	Marks		Criteria
<b>Equipment</b>	2	0 marks	Gives no relevant detail
		1–2 marks	a) Chooses most relevant resources/equipment b) Explains reasons for choices and choices are fully relevant to method

Element	Marks		Criteria
<b>Controls</b> (If variables are to be controlled, criteria a1 and b1 will be used. If there are no variables to control, criteria a2 and b2 will be used. The specific criteria needed will be in the controlled assessment task.)	6	0 marks	Gives no relevant controls
		1–2 marks	a1) Identifies one appropriate variable to control b1) Describes how this variable can be controlled OR a2) Identifies one appropriate way to control the task b2) Describes this way of controlling the task
		3–4 marks	a1) Identifies some relevant variables to control b1) Gives an appropriate description of how to control these variables OR a2) Identifies some relevant ways to control the task to produce meaningful results b2) Describes how these ways control the task
		5–6 marks	a1) Identifies a range of variables appropriate to control b1) Gives an appropriate explanation of how to control these variables OR a2) Provides a comprehensive list of relevant ways to control the task to produce meaningful results b2) Explains how these ways control the task

Element	Marks		Criteria
<b>Hypothesis</b>	4	0 marks	Provides no relevant hypothesis
		1–2 marks	a) Provides a hypothesis that is appropriate for most of the task b) Partially justifies the hypothesis
		3–4 marks	a) Provides hypothesis that is appropriate for the full scope of the task, based on relevant scientific ideas b) Justifies the hypothesis fully using relevant scientific ideas
<b>Risks</b>	4	0 marks	No relevant detail given
		1–2 marks	a) Identifies a relevant risk which is specific to the task b) Suggests measure(s) to manage the risk
		3–4 marks	a) Identifies most of the relevant risks which are specific to the task b) Method reflects how risks need to be managed
<b>Overall plan</b>	4	0 marks	Gives no relevant method
		1–2 marks	a) Method is logically ordered to produce results b) Chooses range of data/observations that would test the hypothesis
		3–4 marks	a) Method is logically ordered to produce results and includes an explanation of why it would test the hypothesis b) Chooses range of data/observations that would test the hypothesis and explains why the range was chosen
<b>Total marks</b>	<b>20</b>		

## Part B - Observations

Element	Marks		Criteria
<b>Primary evidence and recording</b>	4	0 marks	Collects no primary evidence
		1 mark	Records some data/observations that are appropriate for the topic
		2 marks	Collects a suitable range of data/observations and records some appropriately (depends on the practical)
		3 marks	Collects a suitable range of data/observations and records all appropriately (depends on the practical)
		4 marks	Collects a suitable range of data/observations and records all appropriately (depends on the practical) and records further/repeat data
<b>Secondary evidence</b>	2	0 marks	Collects no secondary evidence
		1 mark	Collects and records secondary evidence relevant to the hypothesis in a way appropriate for the topic
		2 marks	Collects and records secondary evidence relevant to the hypothesis in a way appropriate for the topic. Comments on the quality of the sources of secondary evidence
<b>Total marks</b>	<b>6</b>		

## Part C - Conclusions

Element	Marks		Criteria
<b>Processing evidence</b>	4	0 marks	Evidence is not processed
		1–2 marks	a) Attempts to process all collected evidence, using appropriate mathematical skills b) Attempts to present the processed evidence in a way appropriate for the topic
		3–4 marks	a) Processes all collected evidence in a way that is appropriate to the task, using appropriate mathematical skills b) Presents processed evidence in a way that allows conclusions to be drawn
<b>Quality of evidence</b>	4	0 marks	Makes no comments on the quality of the evidence
		1–2 marks	a) Comments on the quality of the primary evidence, dealing with anomalies appropriately (if no anomalies in evidence candidates need to state this) b) Comments on the quality of the secondary evidence, dealing with anomalies appropriately (if no anomalies in evidence candidates need to state this)
		3–4 marks	a) Explains any adjustments to the evidence needed, or decision not to exclude evidence b) Takes account of anomalies in primary and secondary evidence when processing evidence (using all evidence if no anomalies)



Element	Marks		Criteria
<b>Conclusions based on evidence</b>	6	0 marks	Makes no relevant conclusions
		1–2 marks	a) Provides a conclusion based on all collected evidence, but does not link it to the hypothesis b) Attempts to explain the conclusion using all collected evidence, including appropriate mathematical relationships
		3–4 marks	a) Provides a conclusion which refers to the hypothesis based on all collected evidence b) Explains the conclusion using the evidence, including appropriate mathematical relationships
		5–6 marks	a) Provides a conclusion which refers to the hypothesis based on all collected evidence and relevant scientific ideas b) Explains the conclusions using relevant scientific ideas and all collected evidence, including appropriate mathematical relationships
Evaluation of conclusion	4	0 marks	Makes no relevant evaluation
		1–2 marks	a) Evaluates conclusion based on all collected evidence b) Suggests how all collected evidence can be improved to provide stronger support for the conclusion
		3–4 marks	a) Evaluates conclusion based on all collected evidence and relevant scientific ideas b) Suggests how all collected evidence can be improved and extended to provide stronger support for the conclusion

Element	Marks		Criteria
<b>Evaluation of method</b>	6	0 marks	Makes no relevant evaluation
		1–2 marks	a) Identifies a strength or weakness in the method b) Suggests how to improve method and justifies comments made
		3–4 marks	a) Describes strengths or weaknesses in the method and reasons for any anomalies b) Suggests how to improve method and justifies comments made relating to the quality of the evidence collected (including reasons for anomalies)
		5–6 marks	a) Describes strengths and weaknesses in the method and relates them to the hypothesis, and reasons for any anomalies b) Suggests how to improve method, justifying comments made relating to the hypothesis and how better quality evidence could be produced (including reasons for anomalies)
<b>Total marks</b>	<b>24</b>		

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## B Assessment

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### Assessment summary

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Unit B3 is externally assessed by a one hour examination

Unit C3 is externally assessed by a one hour examination

Unit P3 is externally assessed by a one hour examination

Unit FASCA is an internally assessed unit

### Summary of table of assessment

Unit B3: Using biology	Unit code: 5BI3F/5BI3H
<ul style="list-style-type: none"><li>• This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions.</li><li>• The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.</li><li>• Availability: June series.</li><li>• First Assessment: June 2014.</li></ul>	

Unit C3: Chemistry in action	Unit code: 5CH3F/5CH3H
<ul style="list-style-type: none"><li>• This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions.</li><li>• The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.</li><li>• Availability: June series.</li><li>• First Assessment: June 2014.</li></ul>	

Unit P3: Application of physics	Unit code: 5PH3F/5PH3H
<ul style="list-style-type: none"><li>• This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions.</li><li>• The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.</li><li>• Availability: June series.</li><li>• First Assessment: June 2014.</li></ul>	

Unit	Further Additional Science controlled assessment	Unit code: 5SF04
<b>FASCA:</b>		
<ul style="list-style-type: none"> <li data-bbox="225 297 943 327">• This unit is internally assessed under controlled conditions.</li> <li data-bbox="225 340 1410 398">• There will be three tasks available each year – one task from B3, one task from C3, and one task from P3.</li> <li data-bbox="225 412 676 441">• Each task has a shelf life of one year.</li> <li data-bbox="225 454 948 483">• The tasks will be available to teachers one year in advance.</li> <li data-bbox="225 497 1331 526">• Each task has three parts - Part A: Planning, Part B: Observations and Part C: Conclusions.</li> <li data-bbox="225 539 970 568">• The total number of marks available for the three parts is 50.</li> <li data-bbox="225 582 804 611">• Students must attempt all three parts of a task.</li> <li data-bbox="225 624 1385 683">• If they attempt all tasks, then the best marks from Part A, B and C should be submitted for the unit.</li> <li data-bbox="225 696 517 725">• Availability: June series.</li> <li data-bbox="225 739 580 768">• First assessment: June 2014.</li> </ul>		

## Assessment Objectives and weightings

	% in GCSE
AO1: Recall, select and communicate their knowledge and understanding of science	<b>33 – 39%</b>
AO2: Apply skills, knowledge and understanding of science in practical and other contexts	<b>34 – 40%</b>
AO3: Analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence	<b>25.5 – 28.5%</b>
<b>TOTAL</b>	<b>100%</b>

## Relationship of Assessment Objectives to units

Unit	Assessment Objective			
	AO1	AO2	AO3	Total for AO1, AO2 and AO3
Unit B3: Using biology	11 – 13%	7 – 9%	4.5 – 5.5%	25%
Unit C3: Chemistry in action	11 – 13%	7 – 9%	4.5 – 5.5%	25%
Unit P3: Application of physics	11 – 13%	7 – 9%	4.5 – 5.5%	25%
Unit FASCA: Further Additional Science controlled assessment	0%	13%	12%	25%
<b>Total for GCSE in Further Additional Science</b>	<b>33 – 39%</b>	<b>34 – 40%</b>	<b>25.5 – 28.5%</b>	<b>100%</b>

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## Entering your students for assessment

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### Student entry

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From summer 2014 onwards students will be required to sit all of their examinations and submit controlled assessment work for moderation at the end of the course. Students may complete the controlled assessment task(s) at any point during the course. As the controlled assessment task(s) changes each year, centres must ensure that they use the appropriate task for the year of GCSE entry.

Details of how to enter students for this qualification can be found in Edexcel's *UK Information Manual*; a copy is sent to all examinations officers. The information can also be found on Edexcel's website ([www.edexcel.com](http://www.edexcel.com)).

All externally assessed units will be assessed by tiered examinations. Students will need to be entered for a specific tier at the time of entry.

### Forbidden combinations and classification code

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Centres should be aware that students who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

Students should be advised that, if they take two qualifications with the same classification code, schools and colleges are very likely to take the view that they have achieved only one of the two GCSEs. The same view may be taken if students take two GCSE qualifications that have different classification codes but have significant overlap of content. Students who have any doubts about their subject combinations should check with the institution to which they wish to progress before embarking on their programmes.

## Access arrangements and special requirements

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Edexcel's policy on access arrangements and special considerations for GCE, GCSE and Entry Level is designed to ensure equal access to the qualifications for all students (in compliance with the Equality Act 2010) without compromising the assessment of skills, knowledge, understanding or competence.

Please see the Edexcel website ([www.edexcel.com](http://www.edexcel.com)) for:

- the JCQ policy *Access Arrangements, Reasonable Adjustments and Special Consideration*
- the forms to submit for requests for access arrangements and special considerations
- dates for submission of the forms.

Requests for access arrangements and special considerations must be addressed to:

Special Requirements  
Edexcel  
One90 High Holborn  
London WC1V 7BH

## Equality Act 2010

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Please see the Edexcel website ([www.edexcel.com](http://www.edexcel.com)) for information with regard to the Equality Act 2010.

## Controlled assessment

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In controlled assessments, control levels are set for three linked processes: task setting, task taking and task marking. The control levels (high, medium or limited are dependent on the subject) are set for each process so that the overall level of control secures validity and reliability, provides good manageability for all involved and allows teachers to authenticate the student work confidently.

The summary of the controlled conditions for this qualification are shown below.

## Summary of conditions for controlled assessment

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### Levels of control

Internal assessment under controlled conditions has levels of control for task setting, task taking and task marking. These must be adhered to when students are completing their controlled assessment tasks.

#### Summary of levels of control

Area	Level of control
Part A – Planning	Limited
Part B – Observations	Limited
Part C – Conclusions	High

Candidates and teachers will be required to sign a declaration of authentication (see page 81) to indicate that rules have been adhered to.

### Task setting

#### High level of control

A high level of control means that tasks will be set by Edexcel and centres will choose from a list of tasks, from the other units in this qualification.

#### Which task can my students complete?

Candidates cannot submit marks from the same subject for Additional Science (ASCA) and Further Additional Science (FASCA). For example, if a candidate submits a Biology CAT for ASCA, they must submit either Chemistry or a Physics CAT for FASCA.

If a candidate submits part marks from different CATs in ASCA, they may not submit marks from the same subject for the same part in FASCA. For example, if they submit marks for their Part A from Chemistry for ASCA, they must submit a mark for Part A from either Biology or Physics in FASCA.

#### When will the tasks be available?

They will be available on the Edexcel website for teachers to download a year ahead of their first assessment opportunity. Teachers can view all the task sheets available before deciding which task the students will complete.

#### When should the tasks be made available to students?

The task sheets for this controlled assessment are confidential and must not be shown to students before they start the tasks. Task sheets should not be shown to students until the start of the task planning stage of the controlled assessment.



### **Do all my students have to do the same task?**

It is acceptable for all the students in a class to complete the same task. However, the same task does not have to be chosen for all students and they can work on a mixture of different tasks from B3, C3 or P3.

The tasks will change every year, in accordance with the Ofqual regulations for GCSE Science. Teachers must take care when using these tasks to ensure that students are completing the correct task for a particular year. The front sheet of each task will show the dates for which it is valid.

## **Task taking**

### **a Research and data collection – limited level of control**

Research and data collection, including practical work, will be carried out under limited control. This means that students may work collaboratively when collecting data from practical activities.

Students may carry out any secondary research whilst not being directly supervised by a teacher, for example in a library or at home. The secondary research can include extracts from books and websites.

### **b Analysis, conclusions and evaluation of findings – high level of control**

The analysis, conclusions and evaluation will be produced by students under high levels of control. This means that this part of the write-up must be carried out individually by the students, under the supervision of a teacher.

The production of the final report will usually take place over several lessons, so the students' materials must be collected in at the end of the lesson and handed back at the beginning of the next one. Students' final reports must be produced individually.

## **Task marking**

### **Task marking – medium level of control**

A medium level of control means that the marking of the tasks will be carried out by teachers and moderated by Edexcel.

## **Internal standardisation**

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Teachers must show clearly how the marks have been awarded in relation to the assessment criteria. If more than one teacher in a centre is marking students' work, there must be a process of internal standardisation to ensure that there is consistent application of the assessment criteria.

## Authentication

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All students must sign an authentication statement (see page 81). Statements relating to work not sampled should be held securely in your centre. Those that relate to sampled students must be attached to the work and sent to the moderator. In accordance with a revision to the current Code of Practice, any student unable to provide an authentication statement will receive zero credit for the component. Where credit has been awarded by a centre-assessor to sampled work without an accompanying authentication statement, the moderator will inform Edexcel and the mark will be adjusted to zero.

## Further information

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For more information on annotation, authentication, mark submission and moderation procedures, please refer to the *Edexcel GCSEs in Science, Additional Science, Further Additional Science, Biology, Chemistry and Physics: Instructions and administrative documentation for internally assessed units* document, which is available on the Edexcel website.

For up-to-date advice on teacher involvement, please refer to the Joint Council for Qualifications (JCQ) Instructions for conducting controlled assessment document on the JCQ website ([www.jcq.org.uk](http://www.jcq.org.uk)).

For up-to-date advice on malpractice and plagiarism, please refer to the Joint Council for Qualifications (JCQ) *Suspected Malpractice in Examinations: Policies and Procedures and Instructions for conducting coursework/portfolio* documents on the JCQ website ([www.jcq.org.uk](http://www.jcq.org.uk)).

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## Assessing your students

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The first assessment opportunity for all units of this qualification will take place in the June 2014 series and in each following June series for the lifetime of the specification.

### Your student assessment opportunities

#### GCSE in Further Additional Science

Unit	June 2014	June 2015	June 2016
Unit B3: Using biology	✓	✓	✓
Unit C3: Chemistry in action	✓	✓	✓
Unit P3: Application of physics	✓	✓	✓
Unit FASCA: Further Additional Science controlled assessment	✓	✓	✓

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## Awarding and reporting

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The grading, awarding and certification of this qualification will comply with the requirements of the current GCSE/GCE Code of Practice, which is published by the Office of Qualifications and Examinations Regulation (Ofqual). The GCSE qualification will be graded and certificated on an eight-grade scale from A\* to G. Individual unit results will be reported.

The first certification opportunity for the Edexcel GCSE in Further Additional Science will be in June 2014.

Students whose level of achievement is below the minimum judged by Edexcel to be of sufficient standard to be recorded on a certificate will receive an unclassified U result.

## Unit results

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The following table shows the uniform mark at each grade point for a unit that contributes 80 uniform marks towards the overall qualification.

### All units

Unit grade	A*	A	B	C	D	E	F	G
Foundation tier			55	48	40	32	24	16
Higher tier	72	64	56	48	40	36		
Un-tiered unit	72	64	56	48	40	32	24	16

Please note that a Foundation tier unit is restricted to the grades C–G. For this reason, the maximum uniform mark available is 1 uniform mark below grade B (55 uniform marks in this case).

A Higher tier unit is restricted to the grades A\*–D, with an allowed grade E; this allowed grade E being a 'half grade'. For this reason, the grade E uniform mark is set at 36 in this example.

Students who do not achieve the standard required for a grade G will receive a uniform mark in the range 0–15.

### Qualification results

The minimum uniform marks required for each grade:

GCSEs in Further Additional Science Cash-in code: 2SF01

Qualification grade	A*	A	B	C	D	E	F	G
Maximum uniform mark = 320	288	256	224	192	160	128	96	64

Students who do not achieve the standard required for a grade G will receive a uniform mark in the range 0–63.

## Re-taking of qualifications

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Students wishing to re-take a GCSE are required to re-take all the units in the qualification. Students will be permitted to carry forward the results from the controlled assessment unit if they wish and only re-take the externally-assessed units.

## Language of assessment

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Assessment of this qualification will be available in English only. Assessment materials will be published in English only and all work submitted for examination and moderation must be produced in English.

## Quality of written communication

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Students will be assessed on their ability to:

- write legibly, with accurate use of spelling, grammar and punctuation, in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise relevant information clearly and coherently, using specialist vocabulary when appropriate.

## Stretch and challenge

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Students can be stretched and challenged in units through the use of different assessment strategies, for example:

- using a variety of stems in questions – for example analyse, evaluate, discuss, compare, describe, explain
- ensuring connectivity between sections of questions
- a requirement for extended writing
- use of a wider range of question types to address different skills – for example open-ended questions, case studies etc.

## Malpractice and plagiarism

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For up-to-date advice on malpractice and plagiarism, please refer to the Joint Council for Qualifications *Suspected Malpractice in Examinations: Policies and Procedures* document on the JCQ website [www.jcq.org.uk/](http://www.jcq.org.uk/).

## Student recruitment

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Edexcel's access policy concerning recruitment to our qualifications is that:

- they must be available to anyone who is capable of reaching the required standard
- they must be free from barriers that restrict access and progression
- equal opportunities exist for all students.

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## Progression

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- Students who successfully achieve this GCSE in Further Additional Science can progress onto a number of qualifications at Level 3, including GCEs in Biology, Chemistry and Physics.
- Students could also progress onto an Edexcel BTEC Level 3 Applied Science qualification.
- Students could also progress into employment.

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## Grade descriptions

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### Further Additional Science

**A**

Learners recall, select and communicate precise knowledge and detailed understanding of science and its applications, and of the effects and risks of scientific developments and its applications on society, industry, the economy and the environment. They demonstrate a clear understanding of why and how scientific applications, technologies and techniques change over time and the need for regulation and monitoring. They use terminology and conventions appropriately and consistently.

They apply appropriate skills, including communication, mathematical and technological skills, knowledge and understanding effectively to a wide range of practical contexts and to explain applications of science. They apply a comprehensive understanding of practical methods, processes and protocols to plan and justify a range of appropriate methods to solve practical problems. They apply appropriate skills, including mathematical, technical and observational skills, knowledge and understanding in a wide range of practical contexts. They follow procedures and protocols consistently, evaluating and managing risk and working accurately and safely.

Learners analyse and interpret critically a broad range of quantitative and qualitative information. They reflect on the limitations of the methods, procedures and protocols they have used and the data they have collected and evaluate information systematically to develop reports and findings. They make reasoned judgements consistent with the evidence to develop substantiated conclusions.

<b>C</b>	<p>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.</p> <p>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.</p> <p>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.</p>
<b>F</b>	<p>Learners recall, select and communicate their limited knowledge and understanding of science. They recognise simple inter-relationships between science and society. They have a limited understanding that advances in science may have ethical implications, benefits and risks. They use limited scientific and technical knowledge, terminology and conventions, showing some understanding of scale in terms of time, size and space.</p> <p>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.</p> <p>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.</p>



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## C Resources, support and training

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### Edexcel resources

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The resources from Edexcel provide you and your students with comprehensive support for our GCSE Further Additional Science qualification. These materials have been developed by subject experts to ensure that you and your department have appropriate resources to deliver the specification.

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### Edexcel publications

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You can order further copies of the specification, Sample Assessment Materials (SAMs) and Teacher's Guide documents from:

Edexcel Publications

Adamsway

Mansfield

Nottinghamshire NG18 4FN

Telephone: 01623 467 467

Fax: 01623 450 481

Email: [publication.orders@edexcel.com](mailto:publication.orders@edexcel.com)

Website: [www.edexcel.com](http://www.edexcel.com)

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### Endorsed resources

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Edexcel also endorses some additional materials written to support this qualification. Any resources bearing the Edexcel logo have been through a quality assurance process to ensure complete and accurate support for the specification. For up-to-date information about endorsed resources, please visit [www.edexcel.com/endorsed](http://www.edexcel.com/endorsed).

Please note that while resources are checked at the time of publication, materials may be withdrawn from circulation and website locations may change.

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## Edexcel support services

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Edexcel has a wide range of support services to help you implement this qualification successfully.

**ResultsPlus** – ResultsPlus is an application launched by Edexcel to help subject teachers, senior management teams and students by providing detailed analysis of examination performance. Reports that compare performance between subjects, classes, your centre and similar centres can be generated in just a few clicks. Skills maps that show performance according to the specification topic being tested are available for some subjects. For further information about which subjects will be analysed through ResultsPlus, and for information on how to access and use the service, please visit [www.edexcel.com/resultsplus](http://www.edexcel.com/resultsplus).

**Ask the Expert** – To make it easier for you to raise a query with us online, we have merged our **Ask Edexcel** and **Ask the Expert** services.

There is now one easy-to-use web query form that will allow you to ask any question about the delivery or teaching of Edexcel qualifications. You'll get a personal response, from one of our administrative or teaching experts, sent to the email address you provide.

We'll also be doing lots of work to improve the quantity and quality of information in our FAQ database, so you'll be able find answers to many questions you might have by searching before you submit the question to us.

### Support for Students

Learning flourishes when students take an active interest in their education; when they have all the information they need to make the right decisions about their futures. With the help of feedback from students and their teachers, we've developed a website for students that will help them:

- Understand subject specifications
- Access past papers and mark schemes
- Find out how to get exams remarked
- Learn about other students' experiences at university, on their travels and entering the workplace

We're committed to regularly updating and improving our online services for students. The most valuable service we can provide is helping schools and colleges unlock the potential of their learners. [www.edexcel.com/students](http://www.edexcel.com/students)

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## Training

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A programme of professional development and training courses, covering various aspects of the specification and examination, will be arranged by Edexcel each year on a regional basis. Full details can be obtained from:

Training from Edexcel  
Edexcel  
One90 High Holborn  
London WC1V 7BH

Telephone: 0844 576 0027  
Email: [trainingbookings@edexcel.com](mailto:trainingbookings@edexcel.com)  
Website: [www.edexcel.com](http://www.edexcel.com)



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## D Appendices

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## Appendix 1: Codes

Type of code	Use of code	Code number
National classification codes	Every qualification is assigned to a national classification code indicating the subject area to which it belongs. Centres should be aware that students who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the school and college performance tables.	RA1D
National Qualifications Framework (NQF) codes	Each qualification title is allocated a National Qualifications Framework (NQF) code. The National Qualifications Framework (NQF) code is known as a Qualification Number (QN). This is the code that features in the DfE Section 96 and on the LARA as being eligible for 16–18 and 19+ funding, and is to be used for all qualification funding purposes. The QN is the number that will appear on the student's final certification documentation.	The QN for the qualification in this publication is: GCSE in Further Additional Science – 600/6149/2
Unit codes	Each unit is assigned a unit code. This unit code is used as an entry code to indicate that a student wishes to take the assessment for that unit. Centres will need to use the entry codes only when entering students for their examination.	Unit B3 – 5BI3F/5BI3H Unit C3 – 5CH3F/5CH3H Unit P3 – 5PH3F/5PH3H Unit FASCA – 5SF04
Cash-in codes	The cash-in code is used as an entry code to aggregate the student's unit scores to obtain the overall grade for the qualification. Centres will need to use the entry codes only when entering students for their qualification.	GCSE in Further Additional Science – 2SF01
Entry codes	The entry codes are used to: <ul style="list-style-type: none"> <li>enter a student for the assessment of a unit</li> <li>aggregate the student's unit scores to obtain the overall grade for the qualification.</li> </ul>	Please refer to the <i>Edexcel UK Information Manual</i> , available on the Edexcel website

## Appendix 2: How Science Works mapping

How Science Works reference (see page 10)	Unit B3 specification reference
1	1.28, 2.8, 2.12, 2.14, 2.16, 3.4, 3.9, 3.11, 3.12
2	1.18, 1.19, 1.20, 1.23, 1.27, 1.30, 2.4, 2.6, 2.12, 2.14, 2.16, 2.17, 2.18
3	1.8, 1.13, 1.18, 1.19, 2.16, 2.17
4	2.16, 2.18
5	1.28, 2.8, 3.4, 3.9, 3.11, 3.12
6	1.28, 2.8, 2.16, 3.4, 3.9, 3.11, 3.12
7	1.28, 2.8, 3.4, 3.9, 3.11, 3.12
8	1.28, 2.8, 2.16, 3.4, 3.9, 3.11, 3.12
9	Throughout the unit
10	1.23, 1.26, 1.28, 2.8, 3.4, 3.9, 3.11, 3.12
11	1.18, 1.19, 1.23, 1.26, 1.28, 2.8, 2.16, 3.4, 3.9, 3.11, 3.12
12	1.4, 1.16, 1.22, 1.25, 1.29, 2.16, 3.5, 3.7, 3.10, 3.11, 3.12, 3.15, 3.16, 3.17, 3.18, 3.19
13	1.4, 1.16, 1.22, 2.16, 3.16, 3.17
14	1.20, 1.27, 2.12, 2.14, 2.15, 2.16

How Science Works reference (see page 10)	Unit C3 specification reference
1	1.3, 1.4, 2.6, 2.14, 3.8, 3.12, 5.2, 5.9
2	1.4, 2.6, 2.7, 2.14, 3.8, 3.12, 4.1, 5.9
3	2.4, 2.7, 3.2, 3.11, 4.7, 4.8, 4.9, 4.10, 5.10, 5.14, 5.17, 5.19
4	5.4
5	1.4, 2.6, 2.10, 2.11, 2.13, 2.14, 3.8, 3.12, 5.2
6	1.4, 2.1, 2.6, 2.14, 3.8, 3.12
7	0.5, 0.6, 1.4, 2.6, 2.14, 3.8, 3.12
8	1.4, 2.6, 2.14, 3.8, 3.12, 4.2, 5.2
9	Throughout the unit
10	0.2, 0.3, 0.4, 1.4, 2.1, 2.6, 2.7, 2.8, 2.9, 2.14, 2.15, 3.5, 3.8, 3.12, 4.1, 4.2, 4.3, 5.2
11	0.1, 0.2, 0.3, 0.4, 1.4, 2.1, 2.6, 2.7, 2.8, 2.9, 2.14, 2.15, 3.3, 3.4, 3.5, 3.8, 3.12, 4.1, 4.2, 4.3, 5.2, 5.10, 5.14, 5.17
12	1.5, 2.3, 2.5, 3.6, 3.7, 3.13, 3.14, 4.4, 4.5, 4.10, 5.4, 5.6, 5.7, 5.12, 5.15, 5.16, 5.18, 5.20
13	1.5, 4.5, 4.10, 5.4, 5.7, 5.16
14	2.7, 4.1, 4.5, 5.4, 5.10



How Science Works reference (see page 10)	Unit P3 specification reference
1	1.8, 1.17, 1.18, 3.10, 3.12, 3.13, 4.12, 5.7, 5.9
2	1.8, 3.10, 3.12, 3.13, 4.1, 5.7, 5.9
3	1.8, 1.13, 1.14, 1.15, 3.2, 3.5, 3.6, 3.10, 3.12, 3.13, 3.14, 3.15, 3.16
4	4.1
5	1.8, 1.17, 1.18, 4.12, 5.7, 5.9
6	1.8, 1.17, 1.18, 4.12, 5.7, 5.9
7	1.8, 1.18, 4.12, 5.7, 5.9
8	1.8, 1.18, 4.12, 5.7, 5.9
9	Throughout the unit
10	1.4, 1.7, 1.8, 1.9, 1.18, 2.4, 2.5, 2.11, 3.7, 3.8, 4.12, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12
11	1.8, 1.9, 1.13, 1.14, 1.15, 1.18, 2.4, 2.5, 2.11, 3.8, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12
12	1.14, 1.18, 1.19, 1.20, 2.9, 2.10, 2.12, 2.14, 3.1, 3.20, 3.21, 3.22, 3.23, 3.24, 4.6, 4.8, 5.12
13	1.14, 1.18, 1.20, 2.8, 2.12, 3.1, 3.21, 3.22, 3.24, 4.6, 4.8
14	3.21, 3.22, 3.23, 3.24, 4.1, 4.2

## Appendix 3: Mathematical skills mapping

Mathematical skills reference (see page 11)	Unit specification reference		
	B3	C3	P3
1		2.1, 2.6, 2.14, 2.15, 3.12, 4.1, 4.2, 4.3	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
2		2.1, 2.6, 2.8, 2.9, 2.15, 3.12	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
3	1.28, 2.8, 3.4, 3.9, 3.11, 3.12	2.1, 2.8, 2.9, 2.14, 2.15, 4.2, 4.3	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 3.8, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
4		2.1, 2.8, 2.9, 2.14, 2.15	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 2.11, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
5			1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
6	3.3	0.2, 0.3, 0.4, 3.5	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
7	1.28, 2.8, 3.4, 3.9, 3.11, 3.12	2.14, 2.15	
8	1.28, 2.8, 3.4, 3.9, 3.11, 3.12	2.1, 2.7, 2.14, 2.15, 3.12	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
9	1.26, 1.28, 2.8, 2.18, 3.4, 3.9, 3.11, 3.12	3.12	1.4, 1.7, 1.8, 1.9, 1.17, 2.15, 2.4, 2.5, 2.7, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
10		2.1, 2.8, 2.9, 2.15, 3.12, 4.2, 4.3	1.4, 1.7, 1.8, 1.9, 2.4, 2.5, 2.15, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11

Mathematical skills reference (see page 11)	Unit specification reference		
	B3	C3	P3
11	1.26, 1.28, 2.8, 2.18, 3.3, 3.4, 3.9, 3.11, 3.12	3.12	1.4, 1.7, 1.8, 1.9, 1.17, 2.4, 2.5, 2.15, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
12	1.10, 1.12, 1.23, 1.26, 1.28, 1.29, 1.30, 1.31, 1.32, 1.33, 2.8, 2.18, 3.3, 3.4, 3.9, 3.11, 3.12	3.12	1.4, 1.7, 1.8, 1.9, 1.17, 2.4, 2.5, 2.15, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
13			
14			1.4, 1.7, 1.8, 1.9, 2.4, 2.5, 2.15, 3.14, 3.4,
15	3.4		1.4, 1.7, 1.8, 1.9, 2.4, 2.5, 2.15, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
16			5.10, 5.11
17		2.1, 2.8, 2.9, 2.15, 3.12, 4.2, 4.3	1.4, 1.7, 1.8, 1.9, 2.4, 2.5, 2.15, 3.4, 3.14, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
18			1.4, 1.7, 1.8, 1.9, 2.4, 2.5, 2.15, 3.4, 3.14, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
19			

## Appendix 4: The periodic table of the elements

1	2	Key										3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000
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\* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

*The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.*

## Appendix 5: Controlled Assessment Record Sheet

Centre Name:	Centre Number:
Teacher Name:	Qualification Number:
Qualification Title:	Examination Series:
Candidate Name:	Candidate Number:

One mark is required for each of the areas shown in Part A, Part B and Part C. The marks can either be for Part A, Part B and Part C from the same task or from different tasks relating to Units B3/C3/P3 for this GCSE. Centres must retain all parts of the task for moderation.

Part A – Planning			Part B – Observations			Part C – Conclusions		
Marks from	B3/C3/P3 delete as appropriate		Marks from	B3/C3/P3 delete as appropriate		Marks from	B3/C3/P3 delete as appropriate	
Area	Centre mark awarded	Max. mark	Area	Centre mark awarded	Max. mark	Area	Centre mark awarded	Max. mark
Equipment		2	Primary evidence and recording		4	Processing evidence		4
Controls		6	Secondary evidence		2	Quality of evidence		4
Hypothesis		4						
Risks		4				Conclusions based on evidence		6
Overall plan		4				Evaluation of conclusion		4
						Evaluation of method		6
Total		20	Total		6	Total		24
Total for Unit FASCA: Science controlled assessment								

### Declaration of authentication

I declare that the work submitted for assessment is my own work and has been carried out without assistance, other than that which is acceptable under the scheme of assessment. The assessment complies with the rules requirements stated in the summary of conditions on pages 45-46 and 60-61.

Candidate signature \_\_\_\_\_

Teacher signature \_\_\_\_\_

Date final record sheet signed \_\_\_\_\_

By signing the above declaration, you agree to your controlled assessment task(s) being used to support Professional Development, Online Support and Training of both Centre-Assessors and Edexcel Moderators. If you have any concerns regarding this, please contact [Science2011@edexcel.com](mailto:Science2011@edexcel.com).

## Appendix 6: Physics formulae

Formulae sheets will be given to students in their examinations. These will contain all the formulae from the unit which is being examined.

The following formulae are from Unit P3

Specification reference	Equation
1.11	The relationship between electric charge, current and time: charge (coulomb, C) = current (ampere, A) × time (second, s) $Q = I \times t$
2.8	The relationship between voltage, current and resistance: potential difference (volt, V) = current (ampere, A) × resistance (ohm, $\Omega$ ) $V = I \times R$
2.15	The relationship between power, current and voltage electrical power (watt, W) = current (ampere, A) × potential difference (volt, V) $P = I \times V$
2.16	Calculate electrical energy: energy transferred (joule, J) = current (ampere, A) × potential difference (volt, V) × time (second, s) $E = I \times V \times t$
3.4	Calculate speed speed (m/s) = distance (m)/time (s)
3.5	Calculate acceleration acceleration (metre per second squared, $\text{m/s}^2$ ) = change in velocity (metre per second, m/s) ÷ time taken (second, s) $a = \frac{(v - u)}{t}$
3.13	The relationship between force, mass and acceleration force (newton, N) = mass (kilogram, kg) × acceleration (metre per second squared, $\text{m/s}^2$ ) $F = m \times a$
3.14	The relationship between mass, weight and gravitational field strength weight (newton, N) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg) $W = m \times g$
4.4	The relationship between momentum, mass and velocity momentum (kilogram metre per second, kg m/s) = mass (kilogram, kg) × velocity (metre per second, m/s)

Specification reference	Equation
4.9	<p><b>Calculate the momentum conservation for a two-body collision (in one dimension only)</b></p> <p><b>force (newton, N) = change in momentum (kilogram metre per second, kg m/s) / time (second, s)</b></p> <p><b><math>F = (mv - mu) / t</math></b></p>
4.10	<p>The relationship between work done, force and distance.</p> <p>work done (joule, J) = force (newton, N) × distance moved in the direction of the force (metre, m)</p> <p><math>E = F \times d</math></p>
4.13	<p>The relationship between power, work done and time taken</p> <p>power (watt, W) = work done (joule, J) / time taken (second, s)</p> <p><math>P = \frac{E}{t}</math></p>
4.15	<p>Calculate potential energy</p> <p>gravitational potential energy (joule, J) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg) × vertical height (metre, m)</p> <p><math>GPE = m \times g \times h</math></p>
4.16	<p>Calculate kinetic energy:</p> <p>kinetic energy (joule, J) = <math>\frac{1}{2} \times</math> mass (kilogram, kg) × velocity<sup>2</sup> ((metre/second)<sup>2</sup> (m/s)<sup>2</sup>)</p> <p><math>KE = \frac{1}{2} \times m \times v^2</math></p>

## Appendix 7: Certification and cash-in

### Certification and cash-in rules

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Certification for the GCSE in Further Additional Science may be claimed in June providing all of the contributing units have been entered and assessed.

### Externally assessed components

There is one unit code for any common external units.

The result of an external unit can only count towards one qualification. For example, if the result for 5BI3F (Unit 3 foundation tier) is used towards GCSE in Further Additional Science (2SF01), this same unit result cannot be used towards GCSE in Biology (2BI01), or vice versa.





## Specification

To help students fulfil their potential, we have developed a new suite of GCSE qualifications for Science that:

- puts good science at the heart of teaching, learning and assessment
- is presented in clear and detailed specifications
- has examination papers designed and trialled to be accessible with appropriate stretch
- has a clear and achievable approach to new requirements for controlled assessment and practical work
- is designed to allow you to choose the best learning pathway for each student
- supports you with help available online, on the phone and locally.

You will see that this specification is extremely detailed. This is to:

- ensure that you have a clear idea about what might be assessed in an examination
- make it easy for you to plan your teaching
- make sure you don't have to cover material twice in successive units because the progression of ideas is clear.

**[www.edexcel.com/science2012](http://www.edexcel.com/science2012)**

Our website will be regularly updated with a vast range of materials to support you with the delivery of our qualifications, including:

- our accredited specifications, sample assessment materials and sample controlled assessment materials
- free planning and teaching resources
- access to our Subject Advisor Service
- information on our published resources
- access to ResultsPlus, our FREE online results analysis and mocks analysis service
- information on events taking place in your area.

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