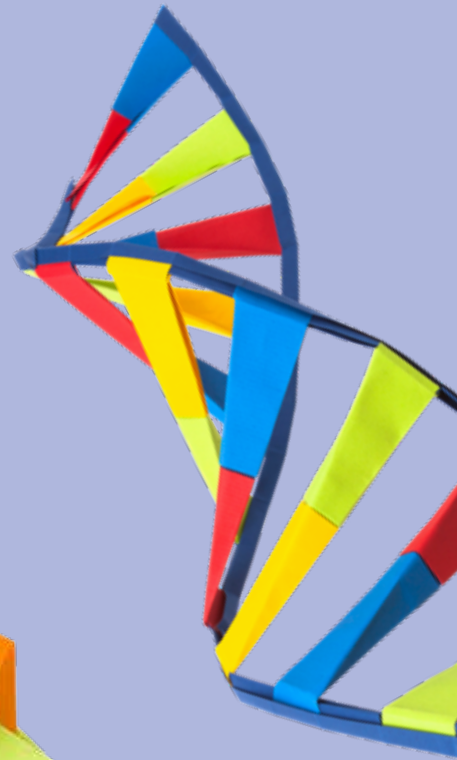


Understanding our exams

GCSE (9–1) Science

A guide to our clear and consistent
approach to writing exams



Supporting success in science


In the GCSE Science team at Edexcel, we pride ourselves on the quality of our assessment materials. Our mission is to ensure that our papers are as accessible as possible to allow every student to demonstrate what they know and can do.

The simple design of our exam papers is something we have developed and perfected in the last ten years. This style is replicated every year so students are familiar with our approach to asking questions, using command words, and the slow ramping of difficulty within a question and across a paper.

We make sure this approach is consistent across Combined Science and Biology, Chemistry and Physics so that students can have the best exam experience year on year.

“

Our learners are at the heart of our assessments, my role is to focus on designing assessments which are fair and accessible for all candidates, and consistent across GCSE and GCE.



Working alongside the Senior Examiners we are careful to develop questions that candidates can access and examine what they know and can apply. I have been making sure our use of language is as clear as possible, and where candidates need to apply knowledge or evaluate information they are presented with sufficient information for them to access the questions.

Our papers also go through a rigorous process of quality checks. At each stage of the development of a paper, a review of the questions are undertaken to ensure careful consideration of the use of language, command words and contexts. Our quality review processes include the input from language modifiers who focus on the question design in terms of sentence structures, words, syllables ensuring that the questions are appropriate for the learner.

I am looking forward to continue with our approach to designing accessible exam papers so that all candidates are able to show us what they know and can do.

Nigel English
Overarching Chair of Sciences
Pearson Edexcel

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The guide aims give you an overview of our content and assessment structure, explain our accessibility principles and give you lots of examples of questions so you can better understand how our exam papers are designed.

Edexcel by numbers

We issue over **100,000** GCSE certificates in the science subjects every year. Each year, we mark over **500,000** science scripts. This amounts to 15 million question items!

Our specifications



Our qualifications offer you clear and straightforward content that develops knowledge and understanding in contexts that are relatable for your students.

Our four specifications in GCSE Combined Science, GCSE Biology, GCSE Chemistry and GCSE Physics are all laid out in the same way, with clear links to core practicals and mathematical skills throughout.

Content overview

We have designed our specifications to help illustrate key features clearly, such as where there is additional content only assessed in separate sciences, and how maths and core practicals are embedded into the specification. Every specification point always starts with a command word, so you know the level of depth and detail required for each section of content.

This extract from our biology specification shows how all these details are laid out:

Topic 6 – Plant structures and their functions		Maths skills
Students should:		
6.1	Describe photosynthetic organisms as the main producers of food and therefore biomass	
6.2	Describe photosynthesis in plants and algae as an endothermic reaction that uses light energy to react carbon dioxide and water to produce glucose and oxygen	
6.3	Explain the effect of temperature, light intensity and carbon dioxide concentration as limiting factors on the rate of photosynthesis	2c, 2d, 2g 4a, 4c
6.4	Explain the interactions of temperature, light intensity and carbon dioxide concentration in limiting the rate of photosynthesis	4b, 4c, 4d
6.5	<i>Core Practical: Investigate the effect of light intensity on the rate of photosynthesis</i>	2c, 2f, 2g 4a, 4c
6.6	Explain how the rate of photosynthesis is directly proportional to light intensity and inversely proportional to the distance from a light source, including the use of the inverse square law calculation	2g 3a 4a, 4b, 4c, 4d
6.7	Explain how the structure of the root hair cells is adapted to absorb water and mineral ions	
6.8	Explain how the structures of the xylem and phloem are adapted to their function in the plant, including: a lignified dead cells in xylem transporting water and minerals through the plant b living cells in phloem using energy to transport sucrose around the plant	
6.9	Explain how water and mineral ions are transported through the plant by transpiration, including the structure and function of the stomata	
6.10	Describe how sucrose is transported around the plant by translocation	
6.11B	Explain how the structure of a leaf is adapted for photosynthesis and gas exchange	2d 5c

Clear command words

Maths opportunities highlighted

Higher tier marked in bold

Core practicals embedded in content

Clear indication of separate science content

Our assessments

Our mission is to ensure our papers are as accessible as possible to allow every student to demonstrate what they know and can do.

The simple design of our papers is something we have worked hard to develop and perfect over the last ten years. This style is replicated every year so students are familiar with our approach to asking questions, using command words, and the slow ramping of difficulty within a question and across every paper.

The table below shows how we have structured our assessments in GCSE Combined Science and the separate sciences GCSE Biology, Chemistry and Physics.

	GCSE Combined Science	GCSE Biology GCSE Chemistry GCSE Physics
Assessments	<ul style="list-style-type: none"> 2 biology papers 2 chemistry papers 2 physics papers Each paper: 60 marks 1hr 10 mins	<ul style="list-style-type: none"> GCSE Biology: 2 papers GCSE Chemistry: 2 papers GCSE Physics: 2 papers Each paper: 100 marks 1hr 45 mins
Question types	multiple-choice questions, scaffolded and short answer questions, calculations, and extended open response questions	
How is content split across the papers?	<ul style="list-style-type: none"> Papers are split according to topic, with half the content for each discipline in one paper (e.g. Biology 1) and half the content in the second paper (e.g. Biology 2). The first topic in each specification lists key ideas that may be assessed in both paper 1 and paper 2. These are either fundamental ideas of the science, e.g. cells in Biology or atomic structure and bonding in Chemistry, or skills, e.g. handling units in Physics. 	

All papers are available at foundation and higher tier. Foundation tier papers are for candidates aiming at grades 1-5. Higher tier papers are for candidates aiming at grades 4-9 (there is an allowed grade 3 for those candidates who just miss the pass mark for the qualification).

GCSE Biology/Combined Science

The table below shows the topics that are assessed in each paper in biology. Within each topic, there is some content that is common to combined science, and some content that goes into extra depth that is only assessed if a student is taking the separate biology GCSE.

Paper 1	Paper 2
Key Concepts in Biology	Key Concepts in Biology
Cells and Control	Plant structures and their functions
Genetics	Animal coordination, control and homeostasis
Natural selection and genetic modification	Exchange and transport in animals
Health, disease and development of medicines	Ecosystems and material cycles

There is one topic that is assessed across both papers, 'Key concepts in Biology'. This topic covers fundamental concepts in biology such as cells which will be drawn upon in other topics, for example this could be included as part of a question on photosynthesis where a candidate would need to understand cells in paper 2, but also in cells and control or genetics in paper 1.

GCSE Chemistry/Combined Science

The table below shows the topics that are assessed in each paper in chemistry.

Paper 1	Paper 2
Key concepts in Chemistry	Key concepts in Chemistry
States of matter and mixtures	Groups in the periodic table
Chemical changes (acids and electrolytic processes)	Rates of reaction and energy changes
Extracting metals and equilibria	Fuels and Earth science
*Separate chemistry 1 (transition metals, quantitative analysis, dynamic equilibria, chemical cells and fuel cells)	*Separate chemistry 2 (Qualitative analysis, hydrocarbons, polymers, alcohols and carboxylic acids, bulk and surface properties of matter including nanoparticles)

The first four topics in each paper are common to combined science, and the final topic in each paper is separate science content only. The 'Key concepts in Chemistry' cover aspects such as atomic structure, which is fundamental knowledge for chemistry and so could be assessed in both papers within the context of the other topics e.g. atomic structure in fuels and hydrocarbons in paper 2, but also understanding activity of acids in chemical changes in paper 1.

GCSE Physics/Combined Science

The table below shows the topics that are assessed in each paper in physics.

Paper 1	Paper 2
Key concepts in Physics	Key concepts in Physics
Motion and forces	Energy – forces doing work
Conservation of energy	Forces and their effects
Waves	Electricity and circuits
Light and electromagnetic spectrum	Static electricity*
Radioactivity	Magnetism and the motor effect
Astronomy*	Electromagnetic induction
	Particle model
	Forces and matter

*separate science topics only

Within each topic, there is some content that is common to combined science, and some content that is separate science only. Two topics are only covered if you are teaching separate GCSE Physics only - Astronomy in paper 1, and Static electricity in paper 2.

The 'Key concepts in Physics' cover fundamental skills that will be woven throughout the topics, such as being able to convert between units, or using significant figures.

Our approach to core practicals

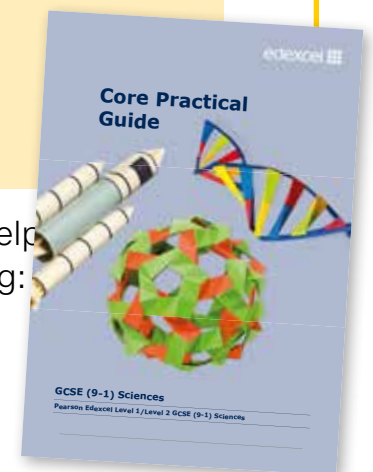
We've integrated our core practicals into the main specification content so you can see exactly how these investigations can be included alongside the content to bring theoretical learning to life.

Practical assessment (15% of marks in exams)

We have **8 core practicals in each separate science GCSE**, and **18 in Combined Science**.

Download our **free Core Practical Guide** designed to help you deliver every core practical in the course including:

- Teaching and learning ideas
- Exam style questions linked to each core practical
- Teacher and student worksheets for all practicals.



Introduction to our exams

Our assessment model was designed in conjunction with teachers to ensure it was the best possible set-up for candidates. We looked closely at design and structure of the papers; this included paper length, mix of questions and how to increase the demand over the course of the paper.

Design and structure of our papers

We have designed our papers so they are as consistent as possible year on year, so you can be confident when using past exam papers that they will be good preparation for your students.

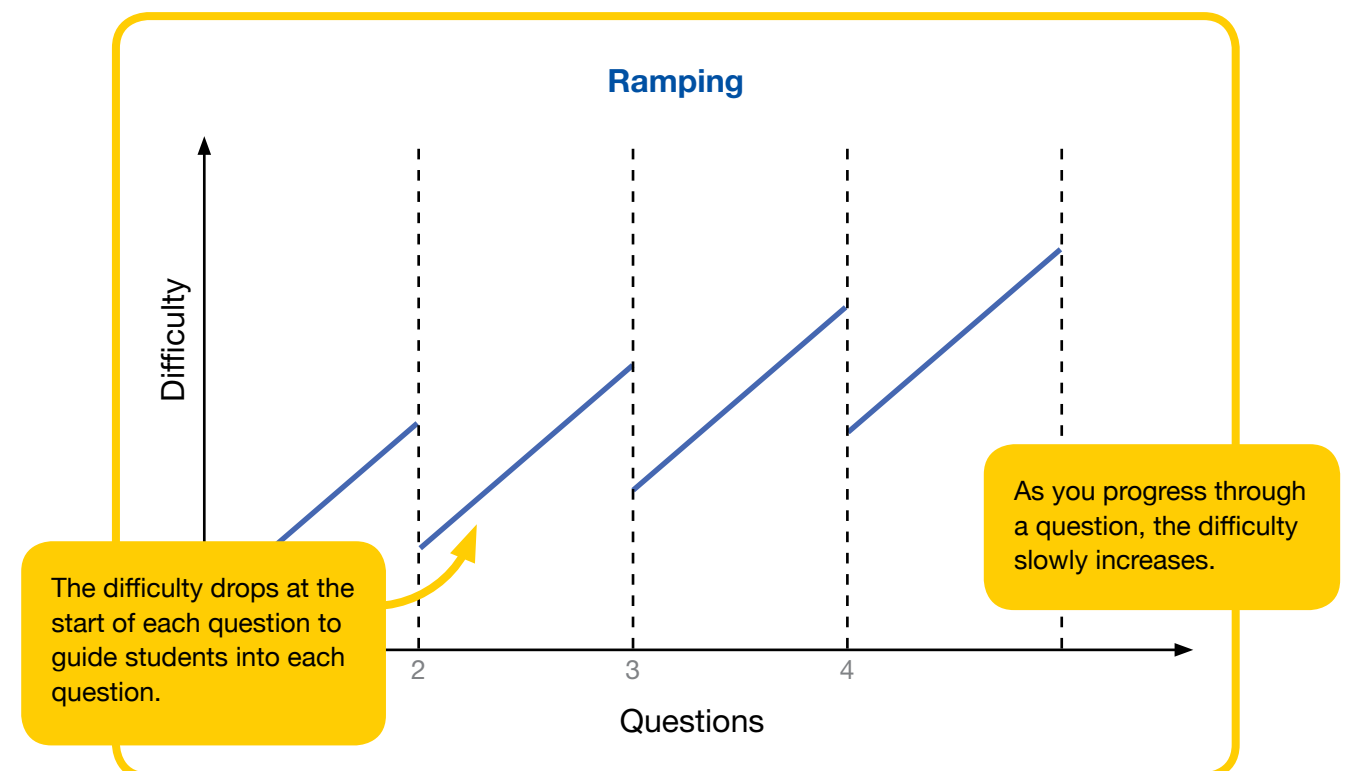
We always have 6 questions in each Combined Science paper, and 10 questions in each separate science paper, so students know what to expect. The number of marks for each question generally increases the further into the paper you get. Each question is split into a number of parts, e.g. 1a, 1bi, 1bii, 1c, which will vary so each question can be tailored to the context.

The mix of items in each paper (multiple choice, short answers and extended open response) is common across papers.

- We ensure that approximately 10% of items are multiple choice.
- In combined science papers you will find 1 x 6 mark item. In separate science, as they are longer papers, you will find 2 x 6 mark item. These will always tend to be towards the end of the paper.
- The remainder are short answer items.

Ramping within questions

Our papers have a simple, consistent style that is used throughout every single science paper. As a candidate progresses through the paper the questions as a whole become more challenging. However, within each question there will still be some items that are accessible to all, thus encouraging candidates to persevere through to the end of the paper. This is something we introduced in our 2011 qualifications and retained for our 2016 qualifications because so many of you have told us it helps your students feel familiar with the style of the exam papers.



I do feel the gradual stepping up of the demands of the question has been beneficial. Having the 6 markers towards the end has helped students 'collect' their thoughts better. I have found the quality of performance of students much better than previous specs. Our students are taught to start at whatever point they want – so they can have a peek at the back pages and ponder on them whilst they tackle the less demanding questions. In this age where students are under so much pressure, I believe this style of examination allows candidates to perform at their best.

S El-Ali, Claremont High

Accessibility

Accessibility is about designing papers that are easily understood by every student. We aim to ensure that the language and design of our papers is clear, consistent and fit for purpose. Our accessibility principles are embedded throughout the creation of our papers, from the structure of our sentences to the spacing and layout of questions on a page.

Key principles

Language and tone

Language experts are involved with every paper. They focus on the clarity of our phrasing and use of key words in our questions, always thinking about learner reading age and how they will access the questions.

Our papers continue to focus on students' understanding of science, we therefore avoid any overemphasis on reading or comprehension.

Command words

We only use one command word in any one item (state and explain is the one exception to this, to ensure that students are clear on the type of response expected).

Command words will always appear at the start of an item unless it is clearer to phrase the question in a different way.

Paper structure and layout

A clear template for each paper is followed for every assessment. This covers elements such as the ramping of questions, skills requirements and different question types. This means every paper is designed in the same way so students are familiar with the format and able to focus on the content and context of each question.

Enough white space in and around questions, and sensible spacing of answer lines so each page is laid out as simply as possible, while laying out question text to guide students through each question.

When designing the layout, we make sure questions do not cross over multiple pages where possible, and try to have data on the same page as the questions to minimise errors appearing when turning pages.

Question style

Choosing a font that has been tested to ensure it is clear to read and at the appropriate size.

Scaffolding questions and answer lines so if a question asks for two pieces of information, the two is bold and '1.' and '2.' usually appear on the answer line as shown below:

(e) Figure 2 gives information about aluminium and tin.

metal	cost of 1 kg / £	amount in Earth's crust / %
aluminium	1.31	8
tin	12.60	0.0002

Figure 2

Give **two** reasons why it could be more important to recycle tin than to recycle aluminium. Use the information in Figure 2.

(2)

Reason 1

Reason 2

Scientific terminology

Scientific terms are used very carefully with a clear reason why each key word is included. The focus is always on assessing a student's science, and not allowing language to become a barrier.

Language experts help throughout the writing of questions to sense check the scientific vocabulary used, and ensure it is covered in the specifications.

Using diagrams and data

Questions that include diagrams and data are usually targeting AO2 or AO3, and so are required to give some stimulus information for students to analyse. When using data, we always ensure it is presented in the most sensible way so students are able to analyse the data given to help inform their answers.

We standardise the way we present graphs and tables, with axes always labelled in the same way, and headings on tables always given with appropriate units.

Diagrams or images are always referred to in the question, allowing students to read a question and understand the relevance of all the information given to them.

Question types

The different question types in the papers include:

1 Multiple Choice Questions (MCQ)

- MCQs help to assess the breadth of content and will appear spread throughout the paper.
- MCQs will have four options to select from.
- MCQs will be written in positive terms and will not rely on a candidate's ability to pick out negative terms (e.g. Which of these is NOT...)
- We will aim to phrase them as a question; the question stem will be a complete sentence, instead of the option completing the sentence.

Biology 1F, Q2 (a)
AO1: Knowledge in isolation, Low demand
Spec ref 5.8

2 Antibiotics can be used to treat chlamydia, which is a sexually transmitted infection.

(a) What type of pathogen causes chlamydia? (1)

A bacteria
 B fungus
 C protist
 D virus

This question requires candidates to identify that chlamydia is caused by bacteria.

There are always four options, with the three incorrect options being words that candidates will recognise from their course of study. Usually these are ordered to be alphabetical.

The question is written as a full sentence, and not as a sentence completion which can be confusing.

Question number	Answer	Mark
2(a)	A	(1)

2 Scaffolded sentence completion/line matching

- Only on Foundation tier.
- In general there will be two extra distractors required. e.g. select three from five.

Chemistry 1F, Q1(a)(ii)
AO2: Low demand
Spec ref 2.3

(ii) A student is given some solid wax.

Use words from the box to name **two** pieces of equipment that the student should use to convert the solid wax into a liquid.

Bunsen burner test tube filter funnel
 burette pipette

(2)

1
 2

Possible answers are clearly set out to ensure pairs of words are considered together e.g. test tube.

Clear spacing between the question, box and answer lines.

The number 'two' is bold in the question, and there are numbers on the answer line to remind students that two answers are required.

Question number	Answer	Mark
1(a)(ii)	<ul style="list-style-type: none"> • Bunsen burner (1) • test tube (1) 	(2)

3 Structured questions

These questions will be 2, 3, or 4 marks in length.

Shorter ones can be more scaffolded.

June 2018 papers

Physics 2F Q8aii A03 medium demand
spec ref: 14.11

8 (a) A student uses the apparatus in Figure 17 to determine the specific heat capacity of water.

DO NOT WRITE IN THIS AREA

(ii) State **two** ways that the apparatus could be adapted to improve the procedure. (2)

1 _____

2 _____

DO NOT WRITE IN THIS AREA

When there is more than one factor that they need to identify, we put it in bold. Here we have arranged the answer lines with a 1 and 2 to ensure candidates don't lose marks just by forgetting they had to mention two factors.

Question number	Answer	Mark
8(a)(ii)	any two improvements from: add lid /cover (1) add lagging / insulation (1) add a stirrer (1) use a more sensitive thermometer (1) ensure heater fully submerged (1)	(2)

Physics 1H Q8 (a)(i)
A03: High demand
Spec ref 6.14, 5.14

Here, students are asked to explain how a filament lamp changes with temperature. It is a higher tier question towards the end of the paper so has a slightly longer introduction. Each sentence is short and succinct and only focuses on one piece of information.

8 (a) All objects emit electromagnetic radiation.

The intensity and wavelength of the emitted radiation vary with the temperature of the object.

Figure 12 shows this variation for a filament lamp at two different temperatures.

The visible region of the electromagnetic spectrum is also shown.

Figure 12

(i) Explain why a filament lamp appears brighter and less red as its temperature increases. (4)

.....

.....

Question number	Answer	Mark
8(a)(i)	An explanation that combines identification via a judgment (2 marks) to reach a conclusion via justification/reasoning (2 marks): <ul style="list-style-type: none"> Intensity of radiation increases with temperature (1) The distribution of the emitted wavelengths of radiation is affected by temperature (1) at low temperatures the intensity of radiation emitted is low and the (range of) emitted wavelengths (of radiation) are high so the lamp appears dull red (1) at higher temperatures the intensity of the radiation is greater and the (range of) emitted wavelengths (of radiation) are low so the lamp appear to be brighter and less red (1) 	(4)

4 Extended open response

- These questions will be 6 marks in length.
- There is no longer a requirement to test quality of written communication (as there was in the 2011 qualifications). However, there is a requirement to test candidates' ability to construct a sustained line of reasoning. Questions assessing this will be marked with an asterisk.
- As these items are more open ended, they are marked using a levels-based mark scheme.

June 2018 papers
Biology 1F Q9b AO2 medium demand
Spec ref: 4.8

*(b) Figure 14 shows two varieties of potato plant.

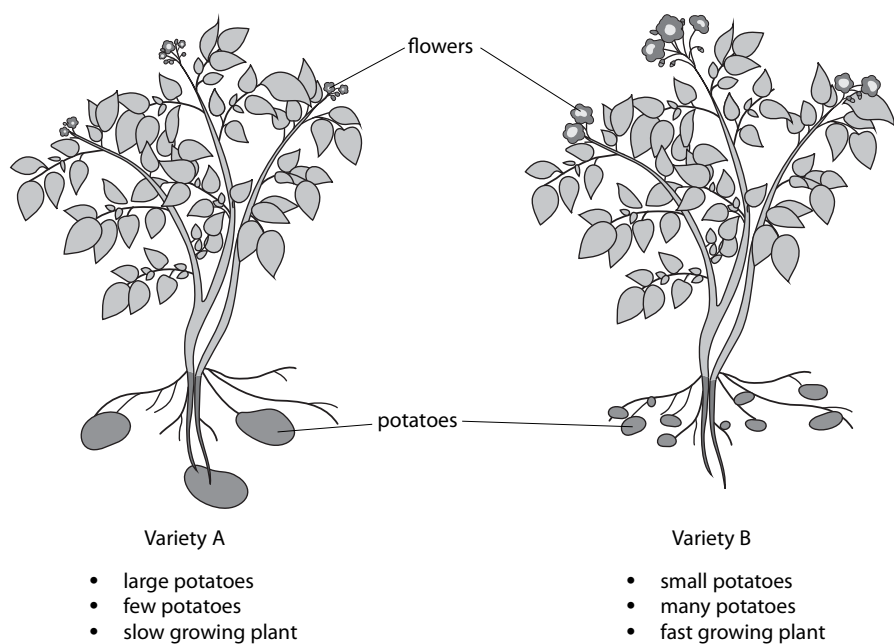


Figure 14

New varieties of potato plant can be produced by selective breeding.

Explain how selective breeding of the two varieties of potato plants can produce new potato plants that are all faster growing and produce many, large potatoes.

(6)

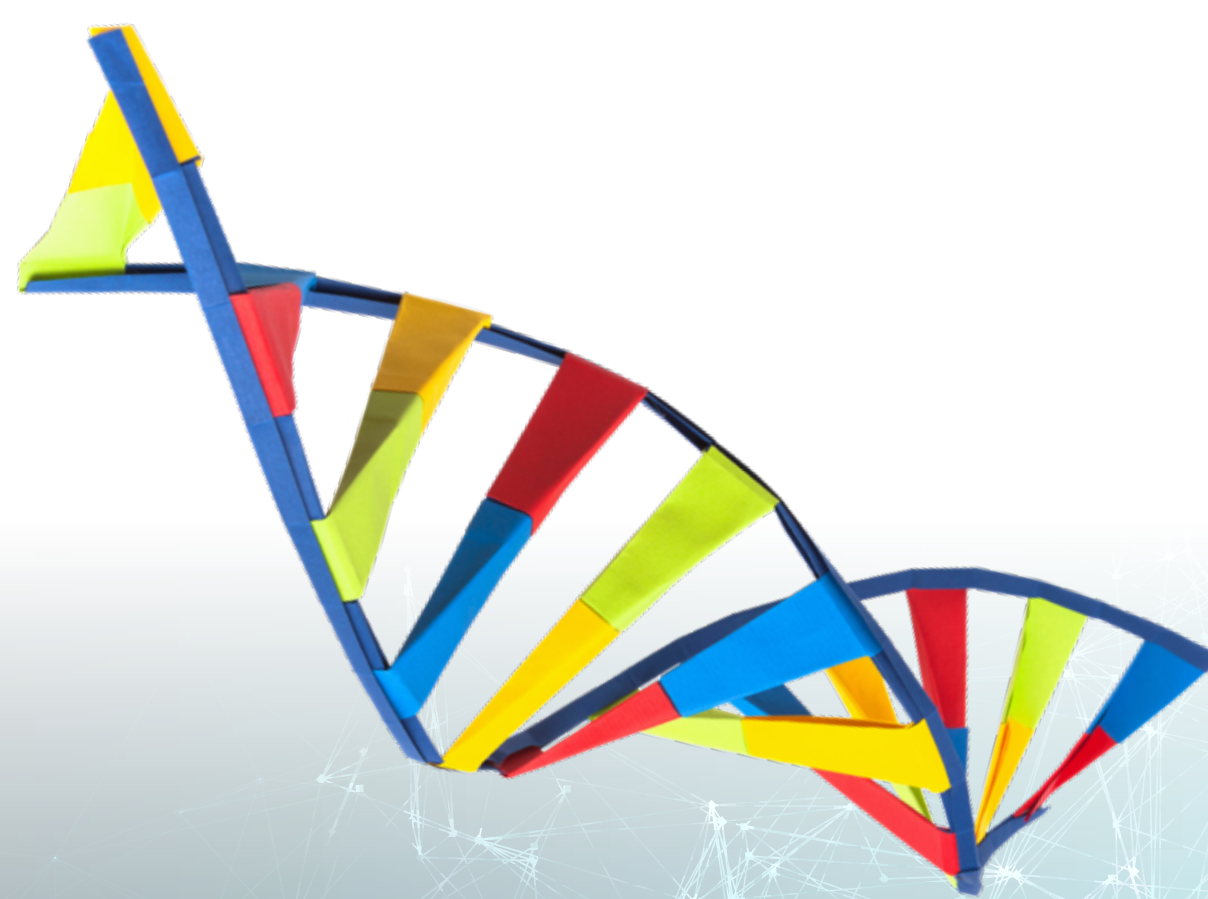
Question number	Answer	Mark
*9(b)	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are therefore not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <ul style="list-style-type: none"> Select variety A because it has large potatoes ; Select variety B because is faster growing and produces many potatoes ; Crossbreed variety A with variety B; Transfer pollen from flower of variety A to flower of variety B / ORA; Grow the new plants Select the offspring with the desired characteristics Repeat the process over many generations; until all offspring show desired characteristics; 	(6)

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	<ul style="list-style-type: none"> The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3-4	<ul style="list-style-type: none"> The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5-6	<ul style="list-style-type: none"> The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Questioning using different AOs

We'll now turn to the interpretation of our assessment objectives, to show how we build our papers. Ofqual require us to have a specific percentage of each assessment objective, as follows:

	Objective	Weighting
AO1	Demonstrate knowledge and understanding of: <ul style="list-style-type: none"> scientific ideas scientific techniques and procedures 	40%
AO2	Apply knowledge and understanding of: <ul style="list-style-type: none"> scientific ideas scientific enquiry, techniques and procedures 	40%
AO3	Analyse information and ideas to: <ul style="list-style-type: none"> interpret and evaluate make judgements and draw conclusions develop and improve experimental procedures 	20%



AO1 questions

AO1 questions are based on knowledge and understanding of both theory from the specification and the core practicals. 40% of items within each paper should be assigned to AO1.

The added complexity is that of *knowledge in isolation*. Knowledge in isolation is defined as any question which elicits candidates to simply recall from the specification without demonstrating understanding. Only 15% of the total marks in a paper should be for knowledge in isolation. The other 25% of total marks dedicated to AO1 should be for the demonstration of understanding. For example, the following is an AO1 question showing elements of knowledge in isolation from the specification content only. Only $\frac{3}{8}$ of AO1 marks can be knowledge in isolation only.

Physics 1H, Q1(a)
AO1: Knowledge in isolation, Medium demand
Spec ref 4.5

1 There are many different types of waves.

(a) Waves on the surface of water are transverse waves.
 Sound waves are longitudinal waves.
 Describe the difference between transverse waves and longitudinal waves. (2)

.....

.....

.....

Question number	Answer	Mark
1(a)	An answer that provides a description by making reference to: <ul style="list-style-type: none"> transverse waves have oscillations perpendicular to direction of travel of the wave (1) whereas longitudinal waves have oscillations in the same direction as the direction of travel of the wave (1) 	(2)

In contrast, the following is an example of an AO1 question which shows both knowledge *and* understanding. A minimum of $\frac{5}{8}$ of AO1 marks should be for knowledge and understanding. You can see in the mark scheme that it allows for demonstration of understanding and not just straight recall.

Biology 1H, Q2(b)
AO1: Knowledge and understanding, Medium demand
Spec ref 5.17

(b) The wire loop used to spread bacteria on an agar plate was heated in a Bunsen burner flame before being used.

Explain why this aseptic precaution was used.

(2)

Question number	Answer	Mark
2(b)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): <ul style="list-style-type: none"> the Bunsen burner flame kills all microorganisms on the loop (1) so only the desired bacteria are transferred to the loop/no unwanted microorganisms spread on the agar plate (1) 	(2)

Core practicals and practical techniques within the specification are also assessed at AO1. This could be knowledge and understanding of the particular technique used, the apparatus used, or more broad understanding of, for example, the limitations of that particular methodology.

June 2018 papers
Physics 2H Q5a AO1, medium to high demand
Spec ref: 12.3

5 (a) A student has a bar magnet, a piece of iron the same size as the magnet, and some paper clips.

Describe how the student could use these items to demonstrate temporary induced magnetism.

(3)

Question number	Answer	Additional guidance	Mark
5(a)	a description to include: method of producing temporary induced magnetism (1) method of demonstrating the magnetic properties of the temporary magnet (1) method of demonstrating magnetic effect is temporary (1)	place iron near / in contact with magnet / in magnetic field OR use magnet to pick up one paper clip OR use magnet to make iron a temporary magnet paper clip(s) attracted to iron OR use first paper clip to pick up another paper clip remove magnet and paper clips no longer attracted / fall off OR wait some / short time and iron bar no longer picks up / attracts paper clips	(3)

AO2 questions

AO2 questions are based on application of knowledge and understanding in novel theoretical and practical contexts. 40% of items within each paper should be assigned as AO2.

In terms of application of practical knowledge, this could be application of a technique or procedure to a novel situation. But it could also be application of investigative skills, for example, data analysis.

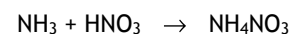
Maths will mostly (but not exclusively) be assessed under AO2.

For example, application of knowledge in a new scenario:

Chemistry 1H Q4(d)
AO2: Medium demand
Spec ref 9.15

(d) Ammonium nitrate is produced from ammonia and nitric acid on a large scale in industry.

Ammonium nitrate can also be made in the laboratory by titrating ammonia solution with dilute nitric acid.



Ammonium nitrate crystals can then be obtained by evaporating off some of the water from the solution.

Give two reasons why this laboratory method is not suitable for use on a large scale in industry.

(2)

Question number	Answer	Mark
4(d)	<ul style="list-style-type: none"> Volumes of solution too large for titration method (1) Large volumes of liquid need to be heated and then allowed to crystallise (1) 	(2)

AO2 can also include mathematical calculations or data analysis:

June 2018 papers
Chemistry 2H Q9bi, AO2: high demand
Spec ref: 1.51a

- 9 (a) The rate of reaction between magnesium ribbon and dilute hydrochloric acid at room temperature is investigated.
 The apparatus used is shown in Figure 11.
 The volume of hydrogen gas given off was measured at regular intervals during the reaction.

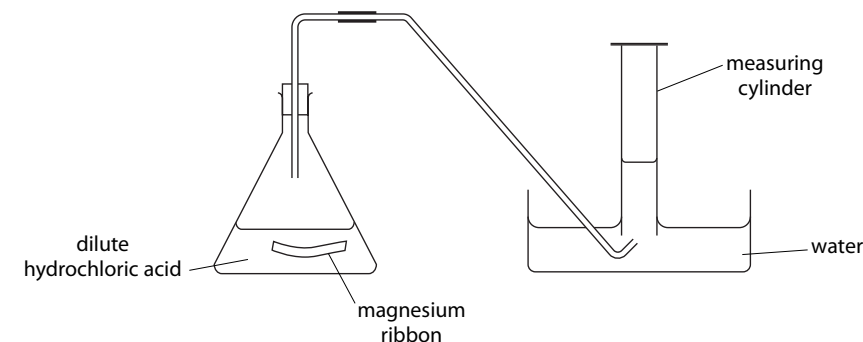
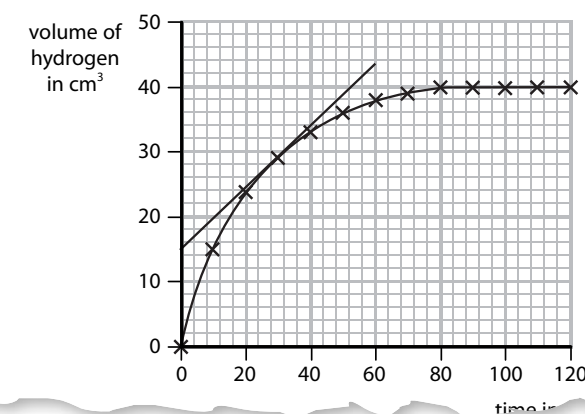
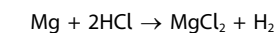


Figure 11

The graph in Figure 12 shows the results of this experiment.



- (b) The balanced equation for this reaction is



- (i) In another experiment, 0.1 moles of hydrochloric acid, HCl, were reacted with 0.1 g of magnesium ribbon.

Calculate the number of moles of magnesium, Mg, in the 0.1 g sample of magnesium ribbon.
 (relative atomic mass: Mg = 24)

(1)

Question number	Answer	Additional guidance	Mark
9(b)(i)	number of moles = $0.1 / 24 = 0.0042$ or 4.2×10^{-3} (1)	ignore answer left as fraction 1/240 rounding must be correct: reject 0.00416 (no dot) allow 0.00416 (with dot above the 6) allow 0.004	(1)

AO3 questions

AO3 questions are likely to be (but not exclusively) more challenging questions, but only 20% of questions will be assigned to this category. They require candidates to analyse information and use that to interpret and evaluate, or draw conclusions, using their understanding of the underlying science. As there is a requirement for analysis of information, questions will have a stimulus for candidates to work from, for example, data, a graph, text.

June 2018 papers

Biology 2H Q9ai AO3 high demand

Spec ref: 9.15

- 9 (a) Figure 17 shows the concentration of the hormones oestrogen and progesterone in the blood of women of different ages.

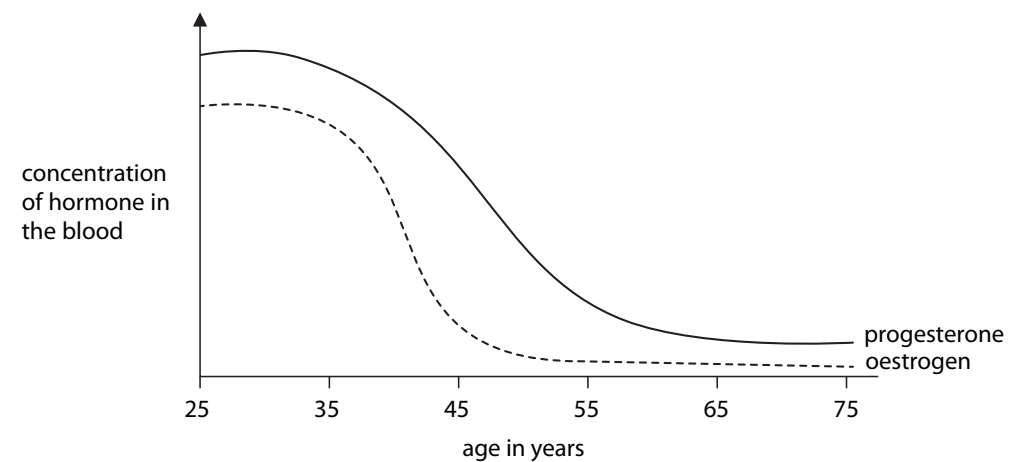


Figure 17

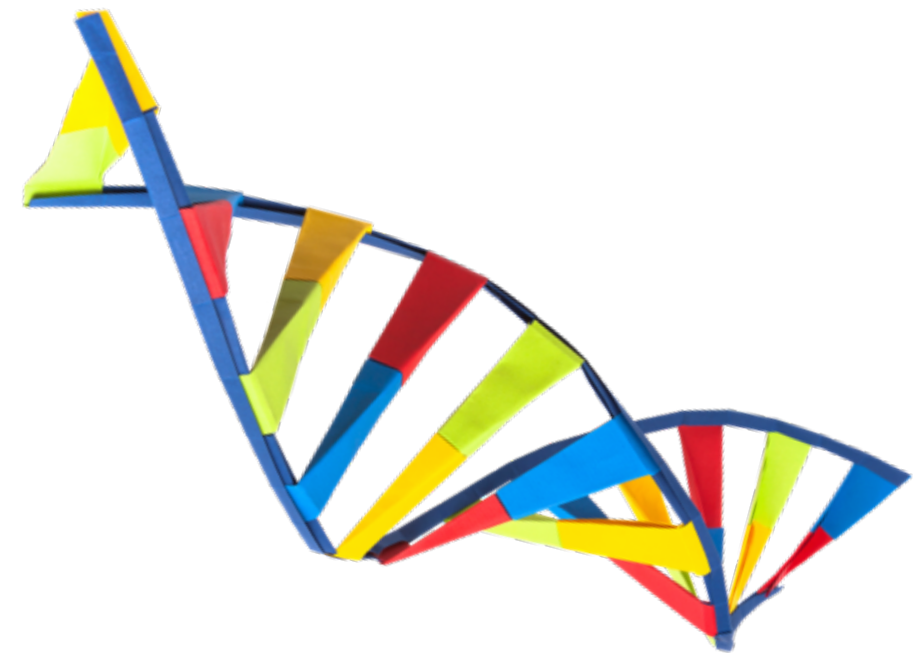
- (i) Use information from Figure 17 to explain why women over the age of 50 are less likely to ovulate.

(2)

Question number	Answer	Mark
9(a)(i)	An explanation linking two of the following: <ul style="list-style-type: none"> women over the age of 50 have low levels of oestrogen (1) (high levels of) oestrogen are needed for LH to be released / levels of oestrogen are too low for LH to be released (1) (a surge of) LH is needed for ovulation to occur (1) 	(2)

They may also be asked enquiry-based questions in a more practical context, for example, to evaluate a novel method and suggest improvements, or to plan a novel practical. NB a question asking candidates to plan will never be a direct lift of a core practical, as that would be AO1. It may be testing a different variable on the core practical, or using a technique they have learnt about in a different practical.

We will deal with AO3 questions appropriately for the tier. For example, planning questions. At Higher tier we may only provide a hypothesis and ask candidates to plan an appropriate experiment. At Foundation tier, more scaffold will be put in place. For example a method may be given showing the testing of one variable, and candidates may be asked to plan to test another variable.



For example, this question asks candidates to evaluate a method and suggest improvements.

Physics 1F Q5(b)
AO3: Low to medium demand
Spec ref 2.11

(b) Two students, Alice and Bob, carry out an experiment to measure the speed of cars.

Alice paces out the distance between two lamp posts.

She records:

'Distance between lamp posts = 20 paces'

Bob starts to count when a car passes the first lamp post. He stops counting when he thinks it has passed the second lamp post.

He records:

'My estimate for the time taken for the car to pass between the two lamp posts = 3'

Give **three** ways the students could improve their experimental procedure. (3)

- 1
- 2
- 3

Question number	Answer	Additional guidance	Mark
5(b)	Any three improvements from: <ul style="list-style-type: none"> • suitable instrument to measure distance (1) • using a greater distance (to reduce effect of reaction times) (1) • suitable instrument to measure time (1) • use of one student at the {first/second} lamp post to signal when to {start/stop} timing (1) 	allow tape measure, trundle wheel allow stop watch/clock or timing app. on phone	(3)

Chemistry 2H Q10(b)
AO3: High demand
Spec ref 7.9

(b) When sodium hydroxide solution is neutralised with an acid there is a temperature change.

A student is given dilute hydrochloric acid and dilute ethanoic acid of the same concentration in mol dm⁻³.

Devise a plan to compare the temperature changes produced when sodium hydroxide solution is neutralised with each of these two acids. (4)

This is a high demand question so it requires students to use their practical knowledge to devise a plan from scratch.

Question number	Answer	Mark
10(b)	An answer that combines the following points to provide a plan: <ul style="list-style-type: none"> • Measure known volume of sodium hydroxide solution (1) • Add same volume of each of the acids (1) • Stir the mixture (1) • Record the initial and final temperatures/temperature change (1) 	(4)

Maths questions

Let's turn now to the new rules around questions assessing maths in the exams.

As regards *how much* mathematics will be assessed, there are set percentages of marks to be allocated to the assessment of mathematical skills.

These percentages are:

Biology – 10%

Physics – 30%

Chemistry – 20%

Combined Science – 20%

As regards *what* mathematics will be assessed, there are two factors to consider.

Firstly, the **breadth of mathematics** to be assessed as specified by the DfE. This can be found in our specification in Appendix 1. This is a list of appropriate mathematical skills to be used in a science context. There is also the specific use of mathematics statements at the end of each topic.

Secondly, the **level of mathematics**, as specified by Ofqual, namely:

KS3 level mathematics for Foundation tier science

Foundation tier level mathematics for Higher tier science.

Not all the mathematics specified by the DfE is at the appropriate standard to count towards the mathematics percentage set by Ofqual, however as part of the content it should be assessed.

Therefore there may be mathematical questions, in addition to the ones that count towards the required percentages, that will be at a lower level than the level specified by Ofqual requirements but will cover the DfE content requirements.

We apply standard rules to the marking of mathematics questions:

We always award full marks for the right answer.

We award marks for working, including substitution and rearrangement.

We will credit where there are errors carried forward.

Science equations

For Physics GCSE and the Physics component of Combined science, there are equations to remember and equations candidates need to be able to apply. There is no such requirement for Chemistry or Biology.

Biology requires students to be able to calculate magnification using information given, as in the example below.

(c) Figure 7 shows some *Vibrio cholerae*, the bacteria that cause cholera.



Magnification $\times 8000$

(Source: Corbis)

Figure 7

The length of one flagellum on Figure 7 is 68 mm.
Calculate the length of the flagellum in μm .

Chemistry still requires students to be able to use formulae in the same way as our previous qualification:

Use relative atomic masses and relative formula masses in calculations

Calculations using moles, mass and molar mass

Calculations using concentration, moles and volume.

Physics equations

Requirements in terms of numbers of equations in physics are as shown below.

Recall and apply

	Number in Combined Science	Number in Physics
Foundation	19	21
Higher	20	22

Apply only

	Number in Combined Science	Number in Physics
Foundation	6	7
Higher	8	11

There will be three scenarios in which we will use these equations.

1 Asking candidates to recall and apply.

This will be from the *recall and apply* list of equations. Candidates will be asked firstly to remember the equation, then apply it.

June 2018 papers
Physics 1F Q2aii AO2 low demand
Spec ref: 4.6

2 (a) A sound wave in air travels a distance of 220 m in a time of 0.70 s.

(i) State the equation linking speed, distance and time. (1)

(ii) Calculate the speed of the sound wave in air. (2)

wave speed = m/s

DO NOT WRITE IN THIS AREA

Question number	Answer	Additional guidance	Mark
2(a)(ii)	substitution (1) (speed) = 220 0.7(0) evaluation (1) 310 (m/s)	allow ecf from part (i) for this mark only allow any numbers that round to 310 e.g.314 award full marks for the correct answer without working	(2)

NB There will be marks given for errors carried forward.

2 Asking candidates to just apply.

In some scenarios, we might actually give one of the equations and ask candidates to apply it. NB this will also be from the *recall and apply* list of equations.

In this instance we don't ask candidates to recall the change in gravitational potential energy equation, instead putting it in the body of the question for them to apply.

June 2018 papers
Physics 1F Q4bi AO2 low demand
Spec ref: 3.1

(b) Figure 7 shows a skier going down a hill.

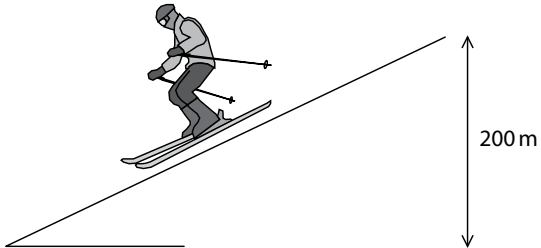


Figure 7

She descends through a vertical height of 200 m.
The skier's mass is 65 kg.

(i) Calculate the change in gravitational potential energy.
Use the equation

$$\Delta GPE = m \times g \times \Delta h$$

Take the gravitational field strength, g , as 10 N/kg. (2)

change in gravitational potential energy = J

DO NOT WRITE IN THIS AREA

Question number	Answer	Additional guidance	Mark
4(b)(i)	substitution (1) ($\Delta GPE =$) 65 x 10 x 200 evaluation (1) 1.3 x 10 ⁵ / 130 000 (J)	allow substitution mark with 65000 (g) allow 1 mark for answers that round to 1.3 with any other power of ten do not allow 13000 award full marks for the correct answer without working	(2)

3 Asking candidates to select and apply

This will be from the *apply only* list which will be given on a formula sheet in the examination. The requirement is that candidates need to be able to select the appropriate formula and use it, so the question will ask the candidate to choose a formula from the formula sheet and perform the calculation.

Physics 2H Q9(b)
AO2: High demand
Spec ref 14.19

(b) A bubble of gas escapes from the submarine.
 The volume of the bubble is 23.0 cm^3 .
 The pressure of the gas inside the bubble is 297 kPa .
 The bubble rises to the surface without changing temperature.
 Calculate the volume of the bubble when it reaches the surface.
 Atmospheric pressure = 101 kPa
 Use an equation from the formula sheet.

(3)

volume = cm^3

Question number	Answer	Additional guidance	Mark
9(b)	rearrangement (1) $V_2 = (p_1 \times V_1) \div p_2$ substitution (1) $V_2 = (297 \times 103 \times 23.0) \div (101 \times 10^3)$ evaluation (1) $V_2 = 67.6(\text{cm}^3)$	67.633	(3)

There can be no set rules around what will be seen at Foundation and Higher tier in terms of handling equations. This is because demand of a question is a composite of both the skill required, e.g. rearrangement of the equation, and the complexity of the equation. For example, rearrangement of $F = m \times a$ is a much simpler prospect than $\text{KE} = \frac{1}{2} \times m \times v^2$.

Other standard maths rules

Graph plotting

We will tend to award two marks for a simple graph plot: 1 mark for plotting the points and 1 mark for a best fit straight line or curve.

If candidates are required to draw a scale for either axis, 1 more mark may be awarded.

Physics 2F Q9(b)(i)
AO2: Medium demand
Spec ref 15.6

(b) The student investigates the stretching of a spring with the equipment shown in Figure 22.

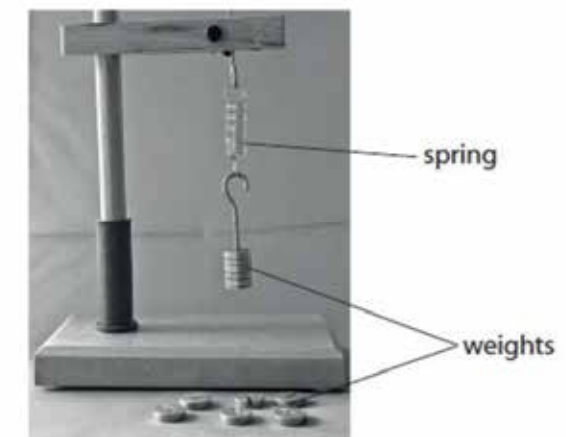


Figure 22

The student investigates the extension of the spring using six different weights.

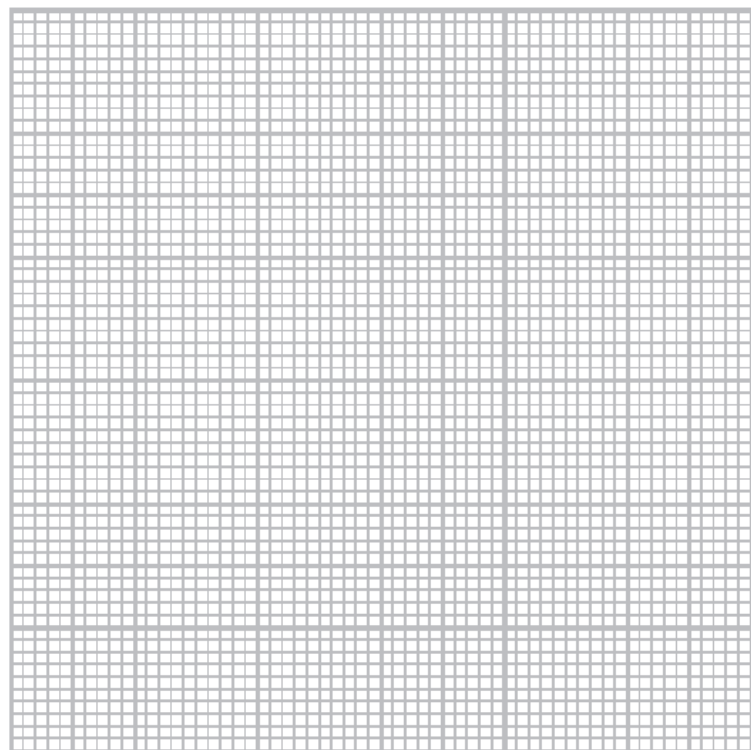
The results are shown in Figure 23.

weight/N	extension /mm
0.20	4.0
0.40	8.0
0.60	12.0
0.80	16.0
1.00	20.0
1.20	24.0

Figure 23

(i) Draw a graph for the readings, using the grid shown.

(3)



Question number	Answer	Additional guidance	Mark
9(b)(i)	<p>Axes with linear scales that use more than half of each edge of the grid and labelled with units from table (1)</p> <p>All points correctly plotted to \pm half a square (1)</p> <p>Single straight line passing through all points and the origin (1)</p>	<p>allow 1 mark if only one plotting error and correct line drawn for points plotted</p>	(3)

Practical questions

We will have at least 15% of marks assigned to the assessment of practical skills. This is assessment of both knowledge of core practicals, but also of candidates' ability to apply that knowledge to new contexts, or to apply investigative skills to scenarios presented in the examinations.

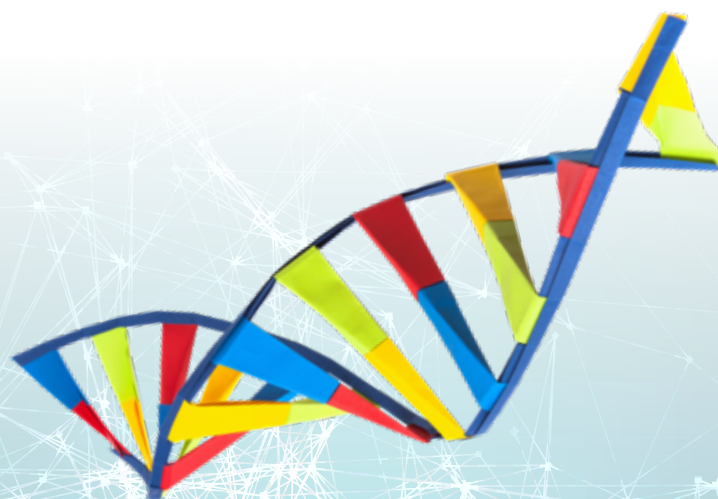
Core Practical

At the heart of all of this is the core practicals. You will notice that we have been careful to precisely define the core practicals we expect. The reason for this is two-fold; firstly to ensure that the methodology centres use is consistent with the apparatus and techniques that the DfE want all learners to experience. Secondly so that we can be clear on what constitutes AO1 and what is AO2. AO1 tests knowledge and understanding of our defined core practicals, so all candidates should know about the specific technique we have outlined. Application of knowledge of these techniques form the basis of AO2 questions. Scientific enquiry type questions form the basis of AO2 and AO3.

For this reason, while it's only compulsory to do the specified core practicals, we do recommend candidates experience a broad range of practical work so they become accustomed to the questions they'll be asked for AO2 and AO3.

It's important to note that questions set in a practical context but testing the theoretical knowledge and understanding will not count towards the marks for practical. Questions that *are* assigned to the 15% allocation are ones where candidates will be at an advantage if they have carried out the core practical.

However, questions that test the more generic processing skills around scientific enquiry, such as data analysis, plotting graphs and calculating means will also not count towards the 15% practical mark total.



Grading and tiering

Grading




When we come to issue grades, it's important to note that marks will be available for each paper, but official grade boundaries will be set for the qualification. This means that grades will be awarded out of 360 marks (6 papers x 60 marks), and each separate science out of 200 marks (2 papers x 100 marks).

We will be issuing notional grade boundaries for each individual paper to help you understand your student marks at a paper level, but these are for indicative purposes only.

Differentiation across the grade range

In general we target questions at three levels of demand – low, medium and high – so that we can effectively differentiate across the grade range. Our examiners are highly skilled in writing questions to target different levels of demand.

Demand is a composite of:

-  the difficulty of the concepts being assessed
-  the cognitive requirements, e.g. explaining a concept is more demanding than recalling it
-  the type of question and the scaffolding used.

Our examiners take all these factors into account when writing papers.

Sometimes you will notice that items can be assigned at two levels of demand, e.g. low to medium. This may be because, even within individual items, some of the marks may be more challenging to achieve than others.

Throughout this guide, we have given examples of items at the different levels of demand in different contexts, to help you gain a better understanding of what each level of demand requires from candidates.

Tiered papers

All science papers are tiered. Foundation tier papers are for candidates aiming at grades 1-5. Higher tier papers are for candidates aiming at grades 4-9. (There is an allowed grade 3 for those candidates who just miss the pass mark for the qualification. This is the same approach as the 2011 qualifications, where candidates who narrowly missed the pass mark can be awarded an E on the higher tier).







Foundation tier or higher tier?

Around half of items in Foundation tier should be targeted at low demand and around half should be targeted at medium demand. Around half of items at Higher tier should be targeted at medium demand and around half should be targeted at high demand.

To ensure that the Foundation tier and Higher tier papers are appropriate for the candidates taking them there are certain key differences between the two tiers. For example in Foundation papers we may use more scaffolding within questions. There will be certain question types such as words in a box, sentence completion, or line matching which will only appear on the Foundation paper.

27% of marks will overlap between Foundation and Higher tier (these will be questions at medium demand). You'll find these towards the end of the Foundation tier paper and near the start of the Higher tier paper.

When considering tier entries for your students, you may want to consider the following points to help inform your decisions:

-  It is important to note that foundation tier covers grades up to 5,5 (in Combined Science), with a grade 4 being anchored to a grade C in the first year.
-  The ramping in our papers is designed to help students persevere through the paper.
-  Foundation tier papers will generally start with lower demand questions to help students build their confidence in answering questions at the beginning of the paper. They will then need to persevere through to the more medium demand questions towards the second half of the paper.
-  Higher tier papers will generally start with medium demand questions, and move on to higher demand questions in the second half of the paper. Students who are at the lower end of higher tier may find that there are fewer questions overall that they can access, as the medium demand questions will tend to be nearer the beginning of the paper.
-  We have overlap questions between foundation and higher tier. One suggestion is to see how students perform with these. As these questions are at medium demand they will tend to be at the start of the higher paper and the end of the foundation paper.
-  You could discuss tier entries with your GCSE Maths departments and see if there are any specific approaches that helped with their decision making.



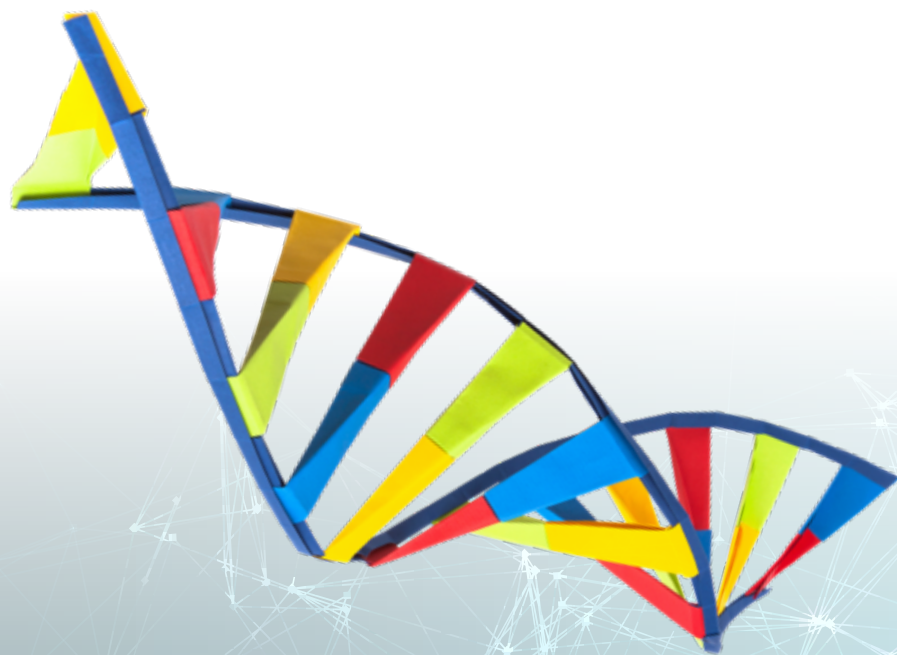
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Secure mock papers

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Command words in our assessments

Command word	Definition
Add/Label	<ul style="list-style-type: none"> Requires the addition or labelling to a stimulus material given in the question, for example labelling a diagram or adding units to a table.
Assess	<ul style="list-style-type: none"> Give careful consideration to all the factors or events that apply and identify which are the most important or relevant. Make a judgement on the importance of something, and come to a conclusion where needed.
Calculate	<ul style="list-style-type: none"> Obtain a numerical answer, showing relevant working. If the answer has a unit, this must be included. This can include using an equation to calculate a numerical answer.
Comment on	<ul style="list-style-type: none"> Requires the synthesis of a number of variables from data/information to form a judgement.
Compare	<ul style="list-style-type: none"> Looking for the similarities or differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question.
Compare and contrast	<ul style="list-style-type: none"> Looking for the similarities and differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question. The answer must include at least one similarity and one difference.
Complete	<ul style="list-style-type: none"> Requires the completion of a table/diagram.
Deduce	<ul style="list-style-type: none"> Draw/reach conclusion(s) from the information provided.
Describe	<ul style="list-style-type: none"> To give an account of something. Statements in the response need to be developed as they are often linked but do not need to include a justification or reason.
Determine	<ul style="list-style-type: none"> The answer must have an element which is quantitative from the stimulus provided, or must show how the answer can be reached quantitatively. To gain maximum marks there must be a quantitative element to the answer.
Devise	<ul style="list-style-type: none"> Plan or invent a procedure from existing principles/ideas.
Discuss	<ul style="list-style-type: none"> Identify the issue/situation/problem/argument that is being assessed within the question. Explore all aspects of an issue/situation/problem/argument. Investigate the issue/situation etc. by reasoning or argument.
Draw	<ul style="list-style-type: none"> Produce a diagram either using a ruler or using freehand.
Estimate	<ul style="list-style-type: none"> Find an approximate value, number, or quantity from a diagram/given data or through a calculation.

Command word	Definition
Evaluate	<ul style="list-style-type: none"> Review information (e.g. data, methods) then bring it together to form a conclusion, drawing on evidence including strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's qualities and relation to its context.
Explain	<ul style="list-style-type: none"> An explanation requires a justification/exemplification of a point. The answer must contain some element of reasoning/justification, this can include mathematical explanations.
Give/State/Name	<ul style="list-style-type: none"> All of these command words are really synonyms. They generally all require recall of one or more pieces of information.
Give a reason/reasons	<ul style="list-style-type: none"> When a statement has been made and the requirement is only to give the reasons why.
Identify	<ul style="list-style-type: none"> Usually requires some key information to be selected from a given stimulus/resource.
Justify	<ul style="list-style-type: none"> Give evidence to support (either the statement given in the question or an earlier answer).
Measure	<ul style="list-style-type: none"> To determine the dimensions or angle from a diagram using an instrument such as a ruler or protractor.
Plot	<ul style="list-style-type: none"> Produce a graph by marking points accurately on a grid from data that is provided and then drawing a line of best fit through these points. A suitable scale and appropriately labelled axes must be included if these are not provided in the question.
Predict	<ul style="list-style-type: none"> Give an expected result.
Show that	<ul style="list-style-type: none"> Verify the statement given in the question.
Sketch	<ul style="list-style-type: none"> Produce a freehand drawing. For a graph this would need a line and labelled axis with important features indicated, the axis are not scaled.
State and explain	<ul style="list-style-type: none"> Make a point and link ideas to justify that point. An explanation requires a justification/exemplification of a point. The answer must contain some element of reasoning/justification, this can include mathematical explanations.
State what is meant by	<ul style="list-style-type: none"> When the meaning of a term is expected but there are different ways of how these can be described.
Write	<ul style="list-style-type: none"> When the questions ask for an equation.

Occasionally we will ask candidates for a suggestion, for example when asking them to apply their knowledge to a novel situation, but the word suggest is not the command word. The command word follows the word suggest. In our analysis of our current papers, we have noticed that candidates struggle to interpret what is being asked in a suggest question, so we add a word which gives more clarity over what is required, e.g. suggest an explanation.

Verbs preceding a command word

Suggest a ...	<ul style="list-style-type: none"> Always used with another command word, e.g. Suggest an explanation.
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Edexcel GCSE (9–1) Science

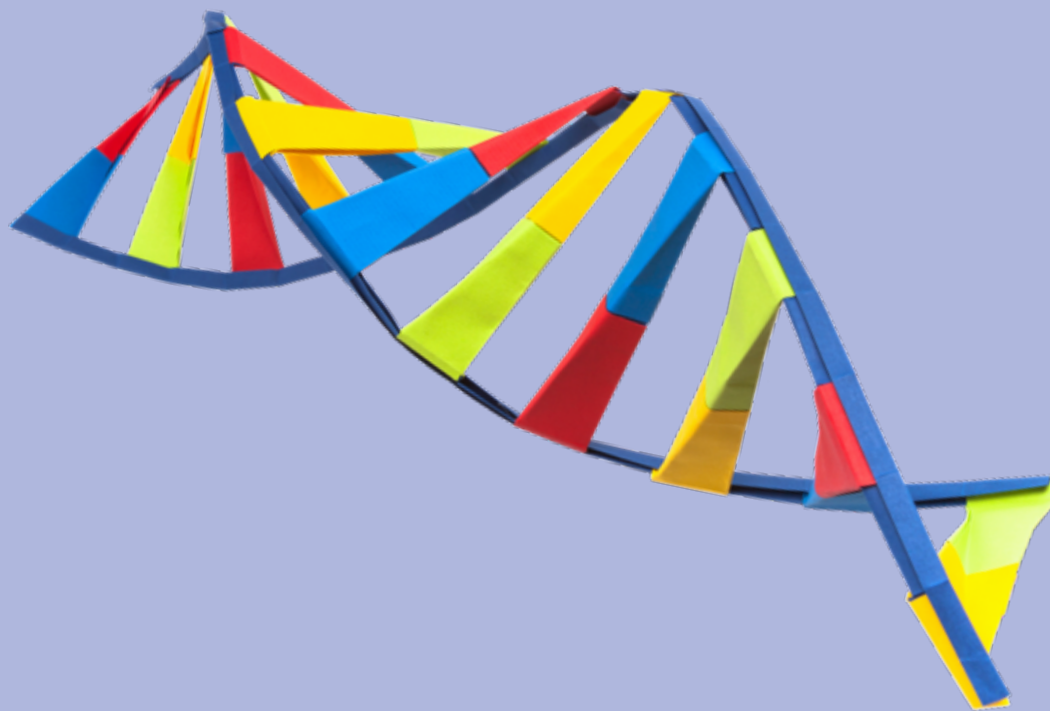
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