T-LEVELS | Institute for Apprenticeships & Technical Education

Exam student pack

T Level Technical Qualification in Science

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Introduction

If you are a student studying the T Level in Health and Science (Science pathway) and preparing for core exams, this support pack is for you.

We know that the exams can seem daunting, and there are so many points to consider and skills to develop, but we, at NCFE, are here to help. This support pack contains guides and activities on various areas to help with your exam preparation, as a supplement to your classes, and will support your independent learning. The support ranges from exam techniques, information about the quality of written communication (QWC), a framework for extended-response questions (ERQs) and more. In addition to guides, this pack contains some activities in each section.

We do not recommend going through all sections at once; it can be a lot to digest. The first section is a self-assessment; this is a good place to start to identify areas where you would benefit from more developing or seeking further support. We recommend you start with these key areas and then work through the others step by step; some sections may be new learning, whilst others are revision – all can help support you in your exam preparation!

Self-assessment

In each of the areas give yourself a RAG rating (red – R, amber – A, or green – G). Rate yourself 'red' if you are not confident, 'amber' if you have some confidence and 'green' if you are very confident. Once you have completed a section of this pack, come back and rate yourself again, saying why you have given yourself that rating. If you are still on red or amber, what are your next steps to turn this to a green?

Area	Rating before		Rating after		Next steps
	RAG	Why?	RAG	Why?	
Exam key terms and requirements					
Key terminology					
Exam techniques					
Quality of written communication (QWC)					
English: foundations					
Maths: foundations					

Area	Rating before		Rating after		Next steps
	RAG	Why?	RAG	Why?	
Tips for exams					
Multiple-choice questions (MCQs) top tips					
Short-answer questions (SAQs) top tips					
Extended-response questions (ERQs) top tips					
Identifying the relevant knowledge and applying correctly to context					

Exam key terms and requirements

Assessment objectives (AOs)

The exam papers have been designed to assess 3 assessment objectives (AOs) as detailed below.

AO1

AO1 is assessing the demonstration of the relevant knowledge and understanding – such as recalling key information or facts. Multiple-choice questions (MCQs), or some questions that just need a one word or one sentence answer, would be examples of questions that only assess this objective.

AO2

AO2 is a higher demand objective that goes beyond just recalling information, and instead into using and applying that knowledge to different situations and contexts. Questions can include completely new and unfamiliar situations and contexts, but the knowledge and principles that have been taught would still apply to this new situation in the question. Many short-answer questions (SAQs) can assess both AO1 and AO2, but some SAQs can also assess AO3.

AO3

AO3 is being able to analyse information and issues and evaluate the situation to make informed judgements and draw conclusions. This might include considering the potential impacts the situation described in the question might have, any future considerations, comparing the pros and cons of a situation and justifying a decision – so it is about the careful consideration of a situation from multiple aspects, and then justifying any decisions or conclusions made.

Command verbs

One thing to look for in an exam question is the command verb, such as state, explain, compare, evaluate, suggest. Getting used to what the command verb is asking for should help to maximise the marks gained in the questions.

It is worth using as many command verbs as possible when revising for different parts of the content in preparation for the exams.

When revising for pathogens as an example, you could try to think of questions involving as many different command verbs as possible.

This can be from lower demand questions such as being able to add labels to a diagram of a bacteria cell – which is much more of a recall of knowledge question, an AO1 question, such as identify – and then more demanding questions such as comparing viruses and bacteria and assessing the suitability of conditions for different pathogens to survive.

Command verb table

Follow this link T Level support materials command verbs to access the different command verbs that will be in your assessments.

Key terminology

Here are some of the key terms from the T level Technical Qualification in Science specification. Once you have covered these areas, or for revision, write their definition in the space provided. There is space at the end for you to add any other terminology you feel would be useful.

Term	Definition
Core component section A: the health and science sector	
Accuracy	
Biohazard (biological agent)	
Controlled variables	
Dependent variable	
Good laboratory practice (GLP)	
Good manufacturing practice (GMP)	
Hypothesis	
Independent variable	
Job description	
Laboratory information management systems (LIMs)	
Negative control	

Term	Definition
Personal protective equipment (PPE)	
Person specification	
Positive control	
Precision	
Primary information source	
Qualitative data	
Quality assurance	
Quality control	
Quantitative data	
Random errors	
Range	
Reliability	
Risk assessment	

Term	Definition
Secondary information source	
Standard deviation	
Standard operating procedure (SOP)	
Systematic errors	
Core component section B: science concepts	
Activation energy	
Aerobic respiration	
Alternating current	
Antibody	
Antigen	
Adenosine Triphosphate (ATP)	
Carbohydrates	
Catalyst	

Term	Definition
Coefficient of viscosity	
Collision theory	
Count-rate	
Density	
Diploid	
Direct current	
Direct transmission	
Deoxyribonucleic acid (DNA)	
Electrical charge	
Electrical current	
Empirical formula	
Enzyme	
Eukaryotic cells	

Term	Definition
Excitation	
Fluid	
Genetics	
Genomics	
Half-life	
Haploid	
Indirect transmission	
Ionisation	
Isotope	
Lipids	
Longitudinal wave	
Mass flow rate	
Meiosis	

Term	Definition
Mitosis	
Mole	
Molecular formula	
Monomer	
Newtonian fluid	
Non-Newtonian fluid	
Pathogen	
Polymer	
Potential difference	
Pressure	
Prokaryotic cells	
Proteins	
Relative isotopic mass	

Term	Definition
Resistance	
Ribonucleic acid (RNA)	
Semi-conservative replication	
Steady flow	
Titration	
Transverse wave	
Turbulent flow	
Viscosity	
Volumetric flow rate	
Wave	
Other terminology	

Term	Definition

Exam techniques

Identify strengths and where to begin

An effective time management strategy is to plan what order you are going to answer the questions in. This will play to your strengths and help build your confidence. The exam papers are divided into 4 sections, with each section addressing different areas of the taught content. In advance of the exams, you should identify which section of the exam paper contains the content you feel most knowledgeable and confident in and you should begin the exam with that section.

Use the table below to identify the content areas within the different sections of the exam paper and add your comments to each section, showing your strengths and weaknesses within the content, and how confident you are feeling. An additional column has been added to allow you to rank the order of the sections, from strongest to weakest.

Exam paper A

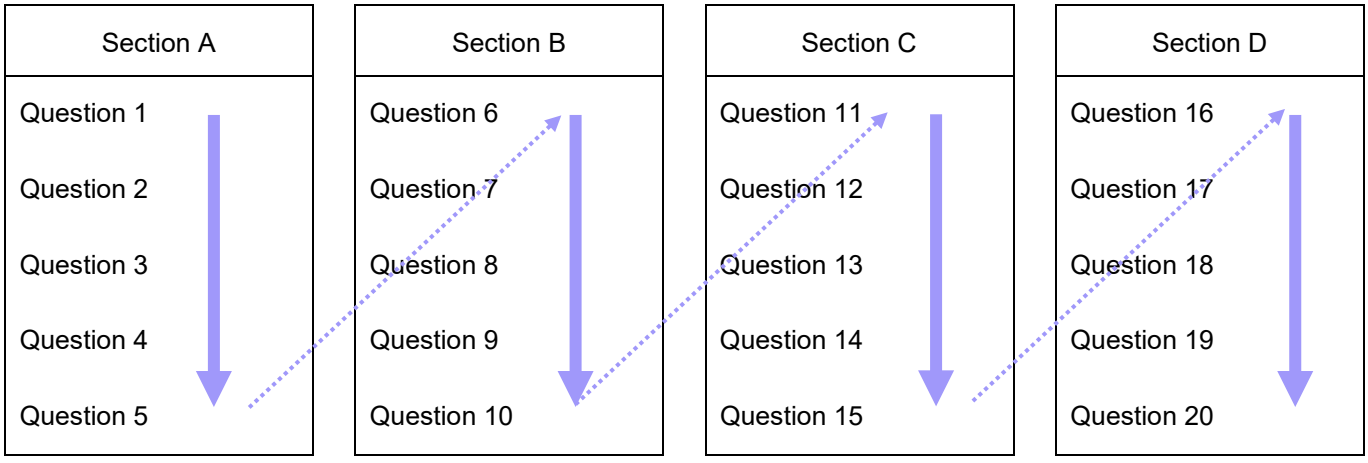
Exam section	Content assessed	Comments	Rank order
Section A			
Section B			
Section C			
Section D			

Exam paper B

Exam section	Content assessed	Comments	Rank order
Section A			
Section B			
Section C			
Section D			

Targeting the lower demand questions

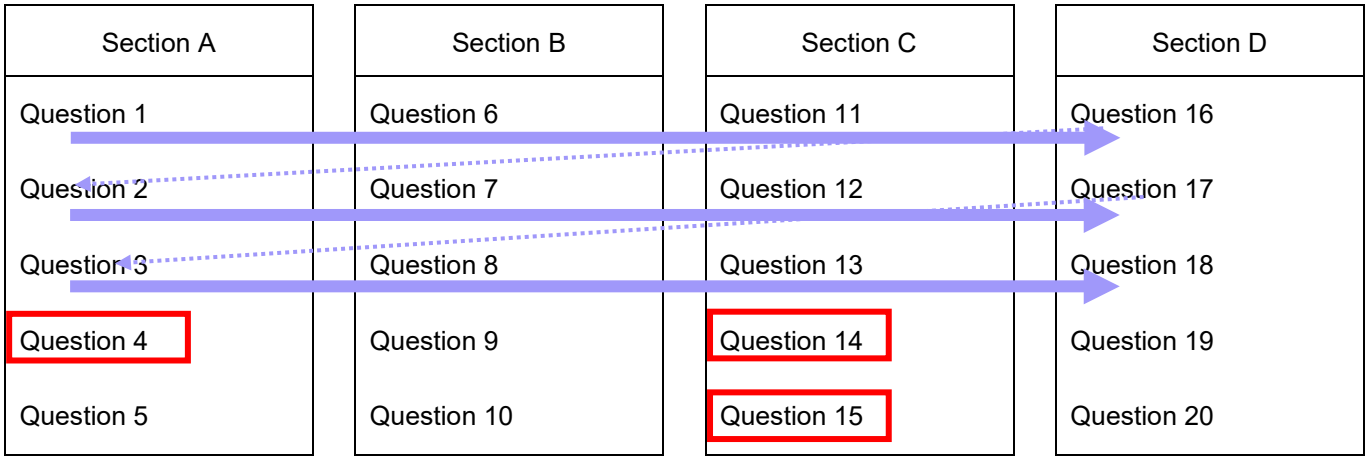
You may be used to taking the traditional approach to answering an exam paper, beginning at question 1 and answering each question in turn (question 2, followed by question 3), as illustrated below with the arrows.



However, each section of the exam paper begins with the lower demand questions, with an increase in challenge and demand as you progress though the section. The exam papers have been designed this way intentionally, as beginning with lower demand or 'easier' questions has been shown to help lower anxiety and settle you into the exam.

By changing your exam approach to the one illustrated below with the arrows, this can help you to secure more marks by addressing the less challenging questions first, rather than missing those opportunities if you had to spend more time on a more difficult question.

This approach will also allow you to 'pick and choose' (example on illustrated boxes below) between the higher demand questions and those you feel most confident with. Higher demand questions usually require a longer answer response.



Time management

Exam time management tips

1. Skim through the paper before you start
2. Budget your time for each question or section
3. Start on the questions or sections you find easiest
4. If you do not know the answer to a question, come back to it later
5. Make an outline for longer answer questions
6. Keep an eye on the clock
7. Taking the time to plan SAQ and ERQ answers helps with proofreading, for example, creating a mind map, lists and notes can help you structure your answers better
8. Stop and breathe

Quality of written communication (QWC)

Think about the **register** and **tone** of what you are going to write:

- what will be the tone/attitude of the writing? think of extended-response questions (ERQs) as professional evaluations, therefore the tone will always be formal

Proofread your writing for readability:

- check one area at a time
  - **spelling** – this includes looking for commonly confused words such as ***there***, ***their*** and ***they're*** or ***practice*** and ***practise*** (for example, homophones – words that have same pronunciation but different meaning or spelling)
  - be aware of your own 'common' mistakes, and check for these (for example, mistyping letters the wrong way round in certain words)
  - **punctuation –** you could take one area at a time (for example, capital letters, full stops, commas, colons, apostrophes, question marks)
  - **grammar** – have you written in full sentences? Have you used the correct subject-verb agreement and tense? Do you jump from past to present?
- ways to proofread
  - place a ruler underneath each line as you read
  - proofread backwards (for example, start on the last paragraph)
- read your writing aloud or in your head when in exam conditions – put yourself in the reader's shoes
- proofread after you have answered the question and then again at the end of the assessment if there is time
- read slowly and carefully – do not skim read!

There are 3 marks available for quality of written communication (QWC) in the ERQs. Be aware of marking criteria and bands for QWC. In the example below, see the key words in bold to get the full 3 marks.

Mark	Descriptor
3	The answer is **clearly expressed** and **well-structured**. The rules of grammar are used with **effective control** of meaning overall. A **wide range** of appropriate technical terms are used effectively.
2	The answer is generally **clearly expressed** and **sufficiently structured**. The rules of grammar are used with **general control** of meaning overall. A **good range** of appropriate technical terms are used effectively
1	The answer lacks some clarity and is generally **poorly structured**. The rules of grammar are used with **some control** of meaning and any errors do not significantly hinder the overall meaning. A **limited range** of appropriate technical terms are used effectively.
0	There is **no answer** written or none of the material presented is creditworthy. OR The answer does not reach the threshold performance level. The answer is **fragmented** and **unstructured**, with **inappropriate use of technical terms**. The errors in grammar severely hinder the overall meaning.

English: foundations

Why spelling, punctuation, and grammar (SPaG)?

Spelling, punctuation, and grammar (SPaG) enables us, as writers, to convey our thoughts in a way that our reader will find easy to understand.

SPaG that is clear and accurate can make you appear more professional and get your message heard.

Employers are more likely to employ people who have good written communication skills.

Apostrophes

There are 2 types of apostrophes:

- **possession** –ownership/belonging (for example, the dog's toy)
- **omission** – where you leave out a letter (for example, I'm a student (Instead of I am))

In formal writing such as reports and articles, apostrophes for omission should be avoided to help keep the formal tone and register.

Apostrophes for possession often cause some confusion.

1. **The *dog's* tail was fluffy.**

Dog is a singular noun, so you need to add an apostrophe and 's' to show that the tail belongs to the dog.

2. ***James's* dog was naughty.**

James is a singular noun so, even though it ends in an 's' already, you need to add an apostrophe and another 's' to show that the dog belongs to James.

3. **The *brothers'* feet were muddy.**

This sentence is referring to more than one brother. Brothers is a plural noun that ends in an 's', so you don't add another 's' after your apostrophe. You can just add an apostrophe to show the feet belong to the brothers.

4. **The *children's* toys were broken**

Children is a plural noun, but it does not end with an 's', so you need to add an apostrophe and an 's' to show that the toys belong to the children.

The following activity is for you to try to recap apostrophes for omission and possession, as well as identifying if they are singular or plural.

Apostrophe activity

You will find the answers to all activities in the appendix of this pack.

Add the apostrophe	Possession/omission	Singular or plural?
My dads name is Amir.		
Pauls dog is very cute.		
I read the research its apparently Harmans Theory of aging.		
Antonios grandma speaks English, Italian and Arabic.		
My sisters friend is coming to visit in an hour.		
Im not sure but I think the physiotherapists are meeting next week.		
The hospitals strategy.		
The Childrens Hospital		
Hes the friend I spend the most time with.		
Thats Davids pen, he must have forgotten it.		
The swimmers families cheered them on.		

Using the correct word

Sometimes words can be confusing as they sound the same but have different spellings and meanings. Below are some words that are often confused, with an activity to help secure understanding of the meanings.

It's or its? **It's:** This is a shortened form of it is or it has and is known as a contraction, for example, it's a sunny day. **Its:** This is a possessive form of the pronoun 'it', meaning that it belongs to it, for example, the book is better than its cover.
The dog had eaten all _____dinner.
____ been a fantastic day, she exclaimed.
The dog licked _____paw.
Let me know when _____ready.

I or me? **I:** This is the subject and used when speaking or referring to the person or doing the action, for example, Ahmed and I handed out the books, or I gave Molly a lift to work. **Me:** This is used when the person speaking is receiving the action, for example, me and Anna are going to see a movie tonight, or Josh carried me.
Who else will be coming to the cinema with John and ____?
The children and ____were sitting on the settee.

Whose or who's? **Whose:** This means belonging to whom, for example, whose jumper is this? **Who's:** This is a contraction (shortened form) of the words 'who is' or 'who has', for example, who's going to the party?
_____ shoes are these?
_____ left their shoes in the doorway again?
I do not know _____number this is.
Do you know _____singing this song?

Accept or except? **Accept:** This is a verb and means to receive something, for example, I accept this gift. **Except:** Is a preposition meaning 'not including' (excluding or with the exception of), for example, we are open every day except Sundays.
I _____your apology.
No dogs allowed _____guide dogs.
Everyone _____the nurses need to attend.
They do not _____credit cards in the shop.

Practice or practise? **Practice:** This is a noun and is used for a name or word, for example, The Happy Health Medical Practice **Practise**: This is a verb and is used when doing something, for example, I am going to practise football.
I am going to visit the new medical _____.
I must _____my breathing techniques.

Practice or practise? **Practice:** This is a noun and is used for a name or word, for example, The Happy Health Medical Practice **Practise**: This is a verb and is used when doing something, for example, I am going to practise football.
On a Friday, the children _____handwriting.
The injection is given at your doctor's _____.

Affect or effect? **Affect:** This is a verb and means to have an impact on or change, for example, poverty can affect anyone. **Effect:** This is a noun and is the result of a change, for example, computers have had a huge effect on our lives.
Does the medication _____the symptoms of the patient?
The new medication has no _____on glucose.

Advise or advice? **Advise:** This is a verb and means to recommend or give information, for example, I advise you to stay at home. **Advice:** This is a noun an opinion or recommendation offered as a guide to action, for example, my advice is to sell your car.
My _____would be to visit your GP.
I _____that you stop smoking.
I asked the doctor for some _____.
Scientists _____that you wear a mask.

Allowed or aloud? **Allow/Allowed:** This means giving permission or making something possible, for example, he was allowed to take his dog into the shop. **Aloud:** This means to say something loudly so others can hear you, for example, the teacher read aloud from the book.
You are not _____ in the restricted area.
The process of learning clinical reasoning may be assisted by using think _____.
The patient was _____to go home.
She read the instructions _____.

Activity

Create an example sentence showing the correct use of each of the following words.

Word	Meaning	Sentence example
Past	Gone in time/no longer	
Passed	To indicate movement	
Advice	A noun that means a suggestion about what you should do (a guide to action)	
Advise	A verb that means to suggest what should be done – to recommend/give info to someone (verb)	
Lose	To fail to win or hold on to something	
Loose	Adjective: not tight, not attached or Verb: to free something or someone.	
Affect	To influence something	
Effect	The result – it represents the end and a good way to remember is both start with an ‘e’.	
Infer	Come to a conclusion, make an educated guess.	
Imply	To suggest, hint at.	

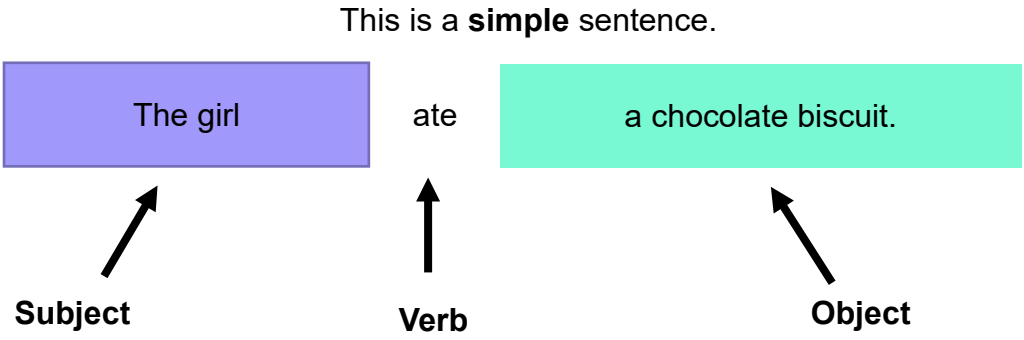
Tenses activity

Identify the tense of the sentence.

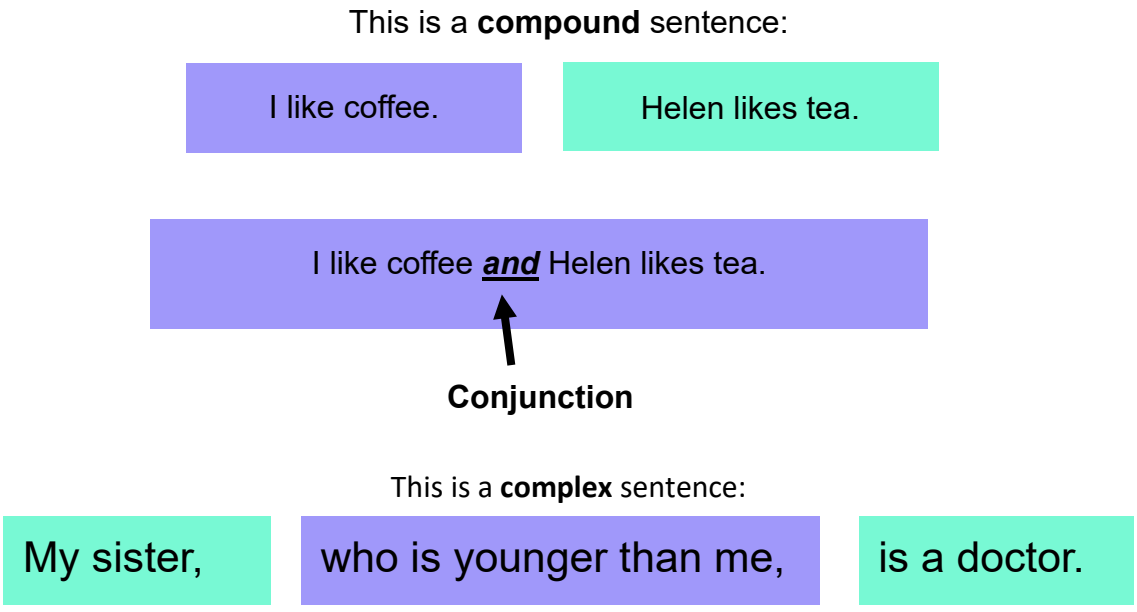
Sentence	Tense: past/present/future
1. We will go to the cinema on Saturday.	
2.Rashid is eating his lunch.	
3. Mario is walking to the shops.	
4. Viktoria slept all day yesterday.	
5. Mr and Mrs Perez are speaking Spanish.	
6. My parents flew from Gatwick airport.	
7. I am going to read a book.	
8. Elena is writing a story.	

Sentences

This is an example of a **main** clause. It is a complete sentence and makes sense by itself.



A compound sentence **connects 2 independent clauses, usually with a coordinating conjunction like, and, or, but**. They combine 2 or more self-sufficient and related sentences into a unified single sentence.



Complex sentences are formed by adding a **subordinate clause** to a main clause.

Subordinate clauses add information to the main clause.

For example: 'who is younger than me' is a subordinate clause as it adds more information to the sentence but **does not make sense on its own.**

A subordinate clause must be separated from the main clause using punctuation (usually a comma).

Sentence activity

What is the sentence type: simple, compound, or complex?

Sentence	Type
Molly, 2 years younger than me, was not allowed to go.	
It was a very sunny day.	
They did not like the food, so they left the restaurant.	
The boy was crying because he had fallen.	
Ahmed, managed to find a chair, while others had to stand.	
I have a dog called Toby.	

Maths: foundations

Maths is an important part of all T levels and indeed, any health and science role. We use maths when calculating doses, to communicate information such as disease statistics, and to determine if treatments are working effectively, amongst others. This section includes guides and questions on a selection of mathematical areas. Give these a go to develop your skills. Please note that the mathematical examples and questions are not exhaustive. If you identify areas you would like to work further on, be sure to speak to your teacher or a maths specialist.

Rearranging formulae

A formula is a relationship between different variables that is expressed algebraically. Often the formula will have application in everyday life, such as the formula for speed or the formula for converting Degrees Celsius to Degrees Fahrenheit.

There may be cases where we wish to rearrange a formula to find a different variable from that formula.

Example 1

Rearrange

$$v = f\lambda$$

to make f the subject.

We can divide both sides by λ which will remove λ from the right-hand side of the equation leaving just f.

$$\frac{v}{\lambda} = f$$

There is our answer!

Rearranging can become more complex when we have more values and with the introduction of algebraic fractions, but it is just a step-by-step process.

Example 2

Rearrange

$$y = \frac{4 + x}{7} - 2$$

to make ***X*** the subject.

The first term we need to remove is '-2', this is because it is the only variable on our right-hand side that is not part of the fraction. We can move the -2 by adding 2 to both sides:

$$y + 2 = \frac{4 + x}{7}$$

The second term we need to remove is the denominator, and we can do this by multiplying both sides by 7.

$$7(y + 2) = 4 + x$$

Notice the use of brackets as the 7 is multiplied by both **y** and 2.

The third term to remove is '4', and we can do this by subtracting this from both sides.

$$7(y + 2) - 4 = x$$

And there we have it! Have a go yourself using the practice questions below.

Practise rearranging formulae

You will find the answers to all activities in the appendix of this pack.

1.Rearrange the following formula to make x the subject:

$$9(x - 4) + 3 = y$$

2.Rearrange the following formula to make x the subject:

$$4y = \frac{t + x}{m}$$

3.The formula to convert degrees Fahrenheit to degrees Celsius is:

$$C = \frac{5}{9}(F - 32)$$

You record a temperature of 36.2 C, use the formula above to convert this into Fahrenheit

4. How much current flows through a 9 V battery that has a resistance of 6.4 Ω? (Hint: You will need to remember Ohm's law)

Using units: dimensional analysis

In the health and science sectors, you may find yourself either performing calculations with no formula or calculating units for an unfamiliar calculation. Both these tasks can be solved with the understanding of one principle: dimensional analysis. The name may sound complicated, but it is essentially using units to your advantage.

First, some background. Whenever you put numbers through a calculation or formula, you are also putting their units through the calculation.

For example, when calculating the speed of a car travelling 200 km in 4 hours using the formula:

$$speed = \frac{distance}{time}$$

We input our values from the question into the formula:

$$\frac{200\ km}{4\ h} = 50\ km/h$$

If we look just at the units, we can see we are treating them algebraically – that is, like an x or y:

$$\frac{km}{h} = km/h$$

Tip: whenever you say 'per' in units, that means divide.

For example, 'km/h' means km divided by hour.

Therefore, if you do not have the formula for calculating speed, or you have forgotten it, you can work it out from the units:

- km/h
  - → kilometres divided by hour
  - → distance divided by time

By the same principle, if you do not know the units, but have the formula, you can calculate the units by putting them into the formula.

Using this principle of dimensional analysis can mean less memorising and can help you out when you are given an unfamiliar equation.

Try the following practice questions using the key points from above (the answers are at the end of this section).

Working out units from formulae/calculations

1. You are preparing a dose of ibuprofen for a patient. You calculate the concentration using the following formula:

$$concentration = \frac{mass}{volume}$$

You dissolve 100 mg in 5 mL, what are the units?

2. Researchers are looking into the effect of dietary acid on the breakdown of tooth enamel. From their experiments, they calculate the rate of decay as mg of enamel broken down per hour. What are the units?

3. When analysing blood samples for haemoglobin concentration to diagnose anaemia, a technician will perform a count for the mass of haemoglobin (measured in g) per litre of blood. What are the units for this?

Working out formula from units

1. Resting heart rate is given in beats per minute (bpm). Therefore, what is the formula to calculate heart rate?

2. The density of copper at room temperature is 8.96 g/cm^3. Therefore, how would you calculate the density of a 200 cm^3 piece of aluminium with a mass of 540 g?

3. The units for moments are Newton-metres (Nm). If you were to calculate the moment experienced by a prosthetic arm holding a weight, what formula would you use? The weight exerts a force of 10 N and the distance of the weight from the elbow of the arm is 0.3 m.

Calculating rate

Rate is a measure we need to calculate in various areas of health and science.

Remember:

$$rate = \frac{change}{time}$$

And the units? The rules of dimensional analysis apply here too!

Have a go at these questions.

1. A newborn baby has an increase in mass of 2 kg in the 6 weeks from birth. Calculate the rate of increase, giving your answer to 2 significant figures. State the units.

2. A clinical researcher is looking at the effect of a new pharmaceutical drug on breathing rate. In a 5-minute period, one subject has 90 breaths. Calculate their respiratory rate in breaths/minute.

3. A chemical reaction produces 500 g of product in 16 minutes. Calculate the rate of reaction and state the units.

Percentages

Calculating percentages, is incredibly useful, both in health and science and in everyday life. In the T level qualification, it falls under GMC2: estimating, calculating and error spotting. In this section, we have step-by-step guides to help you gain confidence with percentages.

Percentage increase

To work out what the new amount will be after a percentage increase:

1. Work out the percentage of the original amount
2. Add that amount onto the original amount

Example

The diameter of a bacterial colony was 1.2 mm after a 2% increase in size, what will the new diameter be?

Work out 2% of 1.2:

1.2 ÷ 100 x 2 **or** 1.2 x 0.02 = 0.024

Add the percentage increase to the original amount:

1.2 + 0.024 = 1.224 mm

(A shortcut would be to simply calculate 1.2 x 1.02 = 1.224)

Percentage decrease

To work out a percentage decrease:

1. Work out the percentage of the original price
2. Take that amount away from the original price

Example

You order personal protective equipment (PPE) that costs £850; however, you have 10% discount code, how much do you now pay?

Work out 10% of £850:

850 ÷ 100 x 10 **or** 850 ÷ 10 **or** 850 x 0.1 = 85

Take the percentage decrease from the original amount:

850 – 85 = £765

(A shortcut would be to calculate 90% of the original 0.9 x £850 = £765)

Calculating percentage change

To work out percentage change between an original value and a final value:

1. Find the difference between the 2 values
2. Divide the difference by the original value
3. Multiply by 100 to change that number to a percentage

Example

The laboratory energy bill in 2020 was £1277, in 2022 the bill is £1971. What is the percentage increase in the cost of energy?

1. Find the difference between £1971 and £1277:
   £1971 – £1277 = £694
2. Divide the difference by the original value:
   694 ÷ 1277 = 0.5435
3. Multiply by 100 to change the decimal into a percentage:
   0.5435 x 100 = 54.35%

Calculating one number as a percentage of another number

1. Divide the number you want to find as a percentage by the other number
2. Multiply the decimal by 100 to convert it to a percentage

Example

A bill for department resources comes to £5600. The PPE equipment ordered was £850. What was the cost of the PPE equipment expressed as a percentage of the total bill?

Divide the cost of PPE by the total cost:

850 ÷ 5600 = 0.1518

Multiply by 100 to convert to a percentage:

0.1518 x 100 = 15.18%

Practise calculating percentages

1. You measure a virus cell that is 48 nm in diameter. Another virus cell is measured to be 124 nm in diameter. How much larger is the second cell given as a percentage?

2. During one week of a disease outbreak, 25,000 people were found to be infected. If the total population is 740,000. What percentage of the population were infected?

3. A group one metal is added to water, and the time taken for a reaction is measured. The group one metal takes 25 s to react. When the water temperature is increased the reaction time goes down to 19 s.

What is the percentage decrease in time taken to react?

4. A cell with a diameter of 0.045 mm is viewed through a microscope, the cell appears to have a size of 18 mm when viewed through the lens.

What is the magnification of the microscope given as a percentage?

General mathematical competencies (GMC)

All T level students (regardless of subject) must develop 10 general mathematical competencies. These are:

- GMC1. Measuring with precision
- GMC2. Estimating, calculating and error spotting
- GMC3. Working with proportion
- GMC4. Using rules and formulae
- GMC5. Processing data
- GMC6. Understanding data and risk
- GMC7. Interpreting and representing with mathematical diagrams
- GMC8. Communicating using maths
- GMC9. Costing a project
- GMC10. Optimising work processes

You will find that there are specific questions within the external assessments that assess against these competencies; however, it is important to consider how maths is assessed within your employer set project (ESP).

The table below can be used to guide your focus when it comes to considering how you would demonstrate the general mathematical competencies:

General mathematical competency	Examples of how GMC is applied to the health and science T Level
GMC1. Measuring with precision	Measuring with precision can include: • choosing the correct equipment for the task • the units and scale of the measurement needed • taking account of any errors, such as zero errors and equipment that is 'off' a set amount • how this zero and systematic error could be affected with further calculations, the error could get compounded • reading calculator screens and choosing the appropriate number of significant figures/decimal places
GMC2. Estimating, calculating and error spotting	The estimation, calculating and error spotting competency can require: • understanding and knowledge of the context in order to find appropriate solutions to calculations • using rules of thumbs when making estimations. For example, an extra inch of height adds 5 pounds of weight • getting a sense check of any calculations performed, so you can be reassured your answer is in line with the expected solution

General mathematical competency	Examples of how GMC is applied to the health and science T Level
GMC3. Working with proportion	Working with proportions can include: • using numbers, ratios and percentages, for example, but also graphical representations, determining trends/pattens • an understanding of direct proportion and inverse proportion – such as in graphs, numbers or qualitative descriptions • applying proportionality to make predictions and draw conclusions, for example
GMC4. Using rules and formulae	Using rules and formulae includes: • knowledge and understanding of how to use rules and formulae given in the specification • general rules as well, such as area and volume calculations, hierarchy of operators for multiplication, division, brackets, addition (BIDMAS) • being able to use formula to find different quantities by rearranging equations • taking account of units and dimensions, and the effect when performing calculations, for example
GMC5. Processing data	Processing data can include: • how the data is collected to begin with • what technology, such as spreadsheets, is used to process the data • how the data is represented and processed such as tables or chart/graph form • being able to interpret already processed data, such as drawing conclusions from provided graphs
GMC6. Understanding data and risk	Understating data and risk can include: • knowledge and understanding of how data is sourced, for example primary, or secondary sources • being able to critically evaluate data • making predictions and drawing conclusions from data • considering how data was generated, for example sample sizes, data source in terms of possible bias
GMC7. Interpreting and representing with mathematical diagrams	Interpreting and representing with mathematical diagrams include: • the creation of suitable diagrams, charts, infographics, for example • being able to interpret diagrams and charts

General mathematical competency	Examples of how GMC is applied to the health and science T Level
	• using technology in their production and setting suitable scales, trend lines, for example
GMC8. Communicating using maths	Communicating with maths includes: • the use of calculations and diagrams to represent your findings and support your conclusions/judgements • using different methods for different audiences – such as information for the general public versus information for professionals/specialists
GMC9. Costing a project	Costing of a project can include: • financial planning, considering the various costs involved, such as equipment, space, time, resources, labour • being able to justify a budget for a certain project • taking into account risks that could potentially impact on any plans
GMC10. Optimising work processes	Optimising work processes can include: • identifying problems from data gathered, such as time requirements, efficiency, financials • suggestions for improvements and any resulting calculations, such as the amount of time saved, how it would affect resources/equipment costs • gather data to analyse the impact that the changes have and evaluate said impact

Tips for exams

Here are some tips to think about when taking an exam and making sure you are prepared.

Top 10 tips to get you started

1. Read the question more than once
2. Make notes of keywords in the questions – you could underline or highlight these to remind you to define or use them in your answer
3. Look at how much space you have been given for the response, if there is a big space it means it will require an extended or in-depth answer
4. Take a note of the number of marks the question has – the bigger the mark, the more detail required
5. Remember, you do not have to do the exam in a sequenced order – if you do not know an answer, move on to another question – go back to any unanswered questions once you have answered all the questions you know
6. Take note of plural words in questions – it may be asking for more than one for example, what are the effects of smoking and age?
7. If you have maths questions, set them out correctly, show working out and add units – this can be useful if you input incorrectly into a calculator or if you get an incorrect answer – you could still be awarded marks for the method and working out
8. What verb is being used in the question? Is it asking you to describe, explain, identify, justify, or assess? each verb has a different meaning, so how and what you respond with will depend on this
9. Plan long response questions so they are constructed in a way that answers the question (for example, quite often people just write everything they know about the topic and the question is left unanswered)
10. Do not leave blank responses – if you cannot think of an answer but know something about the topic, by writing something it gives you the opportunity of being awarded some marks rather than zero if it is not attempted

Science top tips

Following on from the top 10 tips to get you started, here are some top tips that apply specifically to the science exams:

- use the context of the question to identify which specific area of science is being assessed (for example, if the question is in relation to diversity in the workplace, apply your answer to the various types of diversity found in a workplace such as gender, race, disability, or other protected characteristics)
- double check the terminology and phrasing that has been used to ensure you are answering the question correctly (for example, if the question asks how to improve a procedure in response to an accident, make sure any suggestions made improve the procedure and do not directly relate to responding to the accident)
- when analysing any conclusions given in a question, do not repeat the statements made – justify whether you agree or disagree using your own reasoning and subsequent conclusions, remember to be confident in your justification

Tips for different types of exam questions

Multiple-choice questions (MCQs) top tips

Now some handy tips around multiple-choice questions (MCQs), first and foremost, read the MCQ in its entirety before looking at the answer options, do not go to the answers first.

Tip 1: question requirements

The first thing to check is what the question is asking you to address, as there can be some examples which could easily be missed.

- which option would be **unsuitable** for the situation described
- which of the following is **not subject** to…
- calculate the reduction in…
- choose the **direct** transmission methods for…
- which **primary** sources of research should be used for…

Some questions can be asking for the opposite of what might be expected, and spotting these will be important.

- identifying features, principles, regulations that **do not apply** in certain situations
- performing a calculation for an alternative value than what is usually determined, such as a calculation that calculates an increase in something – but the question wants to know the decrease – so remembering to take that one additional step
- has the scope of the question been narrowed? For example, a question about transmission of disease – is it all transmission types or just direct or indirect transmission types?
- is a question about the properties of materials asking about all properties, or just the chemical or physical properties?
- is a question about the pathogens asking about all pathogens, or just bacteria or viruses?

Circling and highlighting this key information on the exam paper is encouraged and will help ensure the question is correctly addressed.

Tip 2: try before checking

Another tip is to answer the question before looking at the options to choose from.

This can help to confirm your choice before answering, or if that option is not available then it should serve as a prompt to re-read the question carefully.

This applies to calculations too, perform the calculation needed and get the answer first – and then check the options.

Choose the correct option:

- 45 kg
- 45 ml
- 45 m

Be aware of similar options.

For example, with calculations some of the values might be similar but the units are different.

There may be more than one option, so circle or highlight any possible candidates, for example, choose 1 option, tick 2 boxes, or choose all that apply.

Sometimes, but not always, the number of marks available will indicate the number of options to choose.

Tip 3: elimination

Finally, even if you do not know what the right answer is, you may know what the wrong answers are.

Start to think about the question and rule out different options.

It is worth noting this on the paper so you can refer back to it. Then just by considering the remaining choices and carefully re-reading the question it could help to gain the marks.

Choose the correct option:

- option 1 ✗
- option 2 ?
- option 3 ✗
- option 4 ?

Study tips for multiple-choice questions (MCQs)

Take a range of sample questions to explore this process. This will increase your confidence when choosing the correct answer from your own knowledge base.

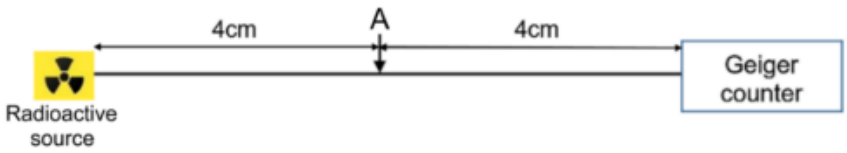
Write your own MCQs as part of a revision activity. You could do this with peers, where you could each write MCQs to explore existing knowledge, then provide answer choices which could be correct or incorrect.

Multiple-choice questions (MCQs) in science exams

Example multiple-choice question (MCQ)

Here is an example MCQ in science.

Study the diagram below:



A physicist places sheets of different materials at point A.

The readings from the Geiger counter are shown below:

Material at point A	Reading from Geiger counter
No material	750
Paper	750
Aluminium foil	150
Lead sheeting	25

What type or types of radiation is the source emitting?

[1 mark]

A β and γ only.

B α and β only.

C γ only.

D β only.

Answer _____

The question covers assessment objective (AO) 1, which assesses the demonstration of the relevant knowledge, understanding of contexts, concepts, theories, and principles in science. This is a 1-mark question therefore, only 1 answer from the options is correct. Now we are going to apply the tips described above to this example:

Tip 1: question requirements

What is the question asking you to address? This could be done by highlighting key words within the question.

What type or types of radiation is the source emitting?

By highlighting the key words in the question, you can identify the words you are looking for within the answer.

You are presented with the diagram showing a radioactive source that is placed 8cm away from a Geiger counter, with point A marked in the middle.

It then tells us that a physicist has placed sheets of different materials at point A and recorded readings from the Geiger counter, which are then shown in the table.

The information given in this table is key to answering the question as to what type of radiation is the source emitting.

Tip 2: try before checking

By following the steps described earlier, try to answer the question before checking the options.

It is clear to see from the readings on the Geiger counter in the table that paper has no effect on the radiation being emitted from the source.

This therefore rules out alpha particles being emitted; due to its low penetrating power it would be stopped by paper and therefore the count rate would reduce.

Next, you can see that the count rate is reduced when aluminium foil is placed at point A.

This would suggest that the radioactive source is emitting beta particles, as they have medium penetrating power and therefore cannot penetrate aluminium foil.

Finally, you will see that there is still radiation detected from the radioactive source when using aluminium foil and lead sheeting, this suggests that there is also gamma radiation being emitted as it has high penetrating power and therefore would be detected with the 2 materials placed at point A.

Tip 3: elimination

Based on the reasoning above, you can now check the answers and eliminate any answers that are incorrect, such as

- **option B** – as we know that alpha is not present
- **option C** – as the amount of radiation detected dropped when using aluminium foil, therefore, it is not gamma only
- **option D** – as there was still radiation detected when using foil and when lead was placed at point A, meaning this cannot be beta only

Now that the 3 options have been confidently eliminated, the correct answer can be chosen. The correct answer is **option A.**

Multiple-choice question (MCQ) activity

Your turn to apply the above tips to this MCQ (answers in appendix A).

Which of these market research mechanisms would produce qualitative data?

[1 mark]

A Asking consumers how many disinfectant products they bought per month.

B Asking consumers to rate a range of disinfectant products by giving each one a score from 1–10.

C Asking consumers why they preferred one disinfectant product more than another.

D Asking consumers how much they spent on disinfectant products per month.

Answer:

Short-answer questions (SAQs) top tips

Now some tips around short-answer questions (SAQs), it is really important the question is read carefully. Here are a few things to look for:

- remember that SAQs require short answers! The marker is looking for very specific points in the answer and it is a waste of time to add extra information that was not asked for: so, keep answers concise and to the point, focus on hitting all the points you need to and give examples if/where appropriate
- read carefully and think about what you should be showing in your answer – and in SAQs, you are probably being asked to **demonstrate and apply knowledge and understanding**
- take note of the important words and phrases in the question and rephrase the question's important terms in your answer – this should help to ensure you stay on topic and include the relevant points
- refer to the first point and use the marks available for each question to inform what you write – 2 marks normally means 2 points you should make, 3 marks you should make 3 points and so on, be aware of this and apply when you are answering this type of question
- practise different command verbs:
    - label the diagram of…
    - describe the basic features of…
    - compare the properties of…
    - assess the suitability of…
    - evaluate the use of…
- does the question have 2 parts or multiple command words, such as describe **and** explain – or explain and justify
- know the style of questions you could be asked:

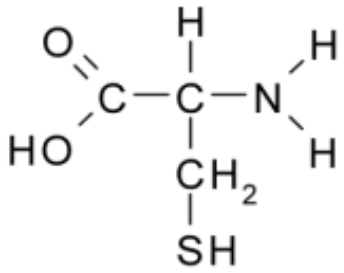
- explain which method would be unsuitable for the situation described
- calculate the reduction in…
- evaluate the direct transmission methods for…
- describe the actions you would take and the impact it would have
- circling and highlighting this key information on the exam paper is encouraged and will help ensure the question is correctly addressed

Short-answer questions (SAQs) in science exams

Example short-answer question (SAQ)

Here is an example SAQ in science.

The diagram below shows the structure of a specific amino acid.



Explain the unique role this amino acid can play in a tertiary protein structure.

[2 marks]

Tip 1: read the question and identify context

In this question, students are presented with a diagram of a specific amino acid.

The question then asks to explain the unique role this amino acid plays within the tertiary protein structure.

This identifies the context as simply, the structures of proteins.

Tip 2: identify the command verb

Identifying the command verb as explain, tells students that they must set out the purposes or reasons that make something clear in relation to a particular situation.

Explain – set out purposes or reasons or make something clear in relation to a particular situation. An explanation requires understanding to be demonstrated.

Linking this to the context of the question, you must set out the purpose of this unique amino acid within the tertiary structure of a protein.

Tip 3: use plain and direct language

Applying the final tips from above, it is important to use plain and direct language when answering the question.

Use short succinct statements to answer question.

Tip 4: apply your knowledge

When applying the knowledge to this question, the main thing to identify is the SH group within the amino acid.

This can then be linked to disulphide bridges which play an important role within the tertiary structure of proteins.

- this amino acid possesses an SH group (1) which can form disulphide bridges with the same amino acid further along the chain, (1) causing the protein to fold in a specific way

Accept any other suitable response

These 2 statements together would achieve 2 marks.

Short-answer question (SAQ) activity

Your turn to apply the above tips to this SAQ question (answers in Appendix A)

Bacteriophages are viruses that infect bacteria. They have adapted to only infect bacterial cell walls and cannot attach to any other type of cell. They attach to the cell wall, inject their DNA, the virus reproduces and the cell dies.

Based on this information, explain whether bacteriophages should be regarded as a biohazard.

[2 marks]

Answer:

Extended-response questions (ERQs) top tips

Extended-response question (ERQ) written response tips

- read the question carefully and at least twice – what are you being asked to do?
- plan your response (for example, list, mind map – you could then number each of them in the order in which you are going to write about)
- use the command term in your response
- when writing your response keep checking to make sure you are still answering the question

- use well-structured sentences
- use subordinating conjunctions in your writing – using words such as *although, because, since, while* and *however* and words/phrases such as *furthermore, moreover, on the other hand, alternatively, by contrast, in comparison, despite this, nevertheless, notably, importantly* and *in conclusion*. This will help you to *analyse*
- use subject specific terminology
- remember does the question include, cause and effect, structure and function, why and how?
- key factors of evaluative writing – do you need to discuss the pros and cons or identify, and explore the strengths/ weaknesses, bring in different/multiple perspectives and be both positive and critical
- if you do not know where to start, use the question to form your answer – this is something you could practise as a revision activity
- remember that for written answers, there are marks for the quality of the written work so apply careful proof reading and check for any mistakes.

Common problems/issues

- apostrophes should only be used for omissions or to show possession
- plural nouns do not always need an apostrophe
- proper nouns need capital letters
- complex sentences need commas (in the correct place) to separate the main and subordinate clauses
- exploring formality, language and tone of writing – especially to ensure clarity and suitability for audience/purpose
- commonly misspelt words in the industry/sector, including homophones
- using English spellings rather than American English
- writing as we speak (for example, *should of* instead of *should have)*
- the suitability of contracted words in academic writing – keep it formal
- using punctuation to effectively clarify meaning, including colons, semi colons, hyphens (also using the Oxford comma)

If you are unfamiliar with any of the above terms, be sure to speak to your tutor!

Tips for extended-response questions (ERQs) key focus areas

Tip 1: practise different command verbs

ERQs are often asking for similar information, with 3 common examples being:

1. The comparison of 2 processes, systems, regulations, equipment for a given circumstance, with any response including justifications for the choices made

2. Examining the use or application of a process, system, regulation in each circumstance, again with those outcomes being justified
3. Finally, it could about what happens if a change is made to a process, system, regulation for a given circumstance, with those justifications being needed again

It is good to have as much practice with a range of extended-response examples. Try to think of practice questions for the content areas, following a similar structure to those examples and using the higher demand command verbs.

Higher demand command verbs:

- **assess** the suitability of…
- **evaluate** the use of…
- **discuss** the implication of…
- **justify** the case for…

Tip 2: what to look for

The first thing is to check what the question is asking to be addressed, as there can be some examples which could easily be missed, and a 3-step approach might be useful.

Step 1: identify the topic/content area that is being addressed

Step 1 is to identify the content areas that the questions are addressing so relevant knowledge can be used, circling and highlighting on the paper is encouraged.

Step 2: identify the circumstances given in the question

The next step is to identify the circumstances, so if it is a comparison then what are the circumstances for this comparison? For example, comparing uses, comparing durability, comparing safety.

Step 3: check if there is a narrowed focus that the response should be refined to

The final step is to check if there is a particular focus that is being asked for. For example, if safety was the circumstance of the question, then check to see if there is a particular focus, such as public safety, patient safety, being safe from **direct** transmissions or diseases, or being safe from **indirect** transmissions of diseases.

If there is a narrowed focus, then the answer should revolve around that focus only.

Tip 3: planning the answer

Now that the question requirements have been determined, the answer can now be planned.

See framework for extended-response questions (ERQs) section of this document for more details.

Tip 4: the importance of quality of written communication (QWC)

The last aspect is composing the final answer, many ERQs have 3 marks available for the quality of written communication (QWC).

These marks are independent to the knowledge marks, so it is possible to have an entirely incorrect response that will still gain 3 marks if it is well written.

There are 3 aspects to the QWC marks:

- firstly, the answer should have a good flow, an orderly structure (for example, use paragraphs) and use unambiguous plain English
- secondly, spelling, punctuation and grammar are also assessed, (for example, using the correct subject-verb agreement and tense, and the use of commas, full stops, capital letters)
- thirdly, the key terms, so referring to the question – are there any key terms that the answer should include? Are there any additional key terms from the content area that were noted during the planning, and does the use of these key terms enhance the clarity of the sentence?

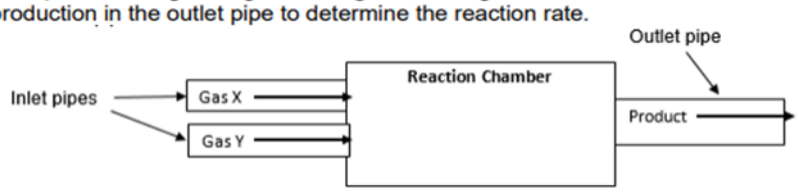
See quality of written communication (QWC) section of this document for more details.

Extended-response questions (ERQs) in science exams

Example extended-response question (ERQ)

Here is an example ERQ in science.

8 A scientist wanted to maximise production rate by finding out the optimum distribution for using a catalyst. He passed two gases, gas X and gas Y, through a reaction chamber. He measured the rate of production in the outlet pipe to determine the reaction rate.



The same mass of catalyst was used in arrangements A, B and C.

The reaction was carried out at different temperatures.

The rate of reaction is given in arbitrary units.

	A	B	C
Temperature of reaction chamber °C	**Reaction chamber lined with a layer of catalyst**	**Reaction chamber with the catalyst in granular form at the bottom**	**Reaction chamber divided into a 'honeycomb' of hundreds of smaller tubes each lined with catalyst**
50	0	0	0
60	0	0	0
70	0	0	0
80	5	4	6
90	10	8	12
100	22	17	25
110	40	33	48
120	150	164	210

Evaluate the methods used to find the optimum distribution for the catalyst. Use data from the table to support your answer.

Your response should include:

- reasoned judgements and/or conclusions.

[9 marks plus 3 marks for QWC]

In this question, a scientist wants to maximise the production rate by finding the optimum distribution for using a catalyst.

He passes 2 gases, X and Y, through a reaction chamber and then measures the rate of production in the outlet pipe in order to determine the reaction rate.

The same mass of catalyst was used in each arrangement but was carried out at different temperatures.

In arrangement A, the reaction chamber was lined with a layer of catalyst.

Within arrangement B, the catalyst was in granular form on the bottom of the reaction chamber.

And in arrangement C, the chamber itself was divided into a honeycomb structure, with hundreds of smaller tubes each lined with the catalyst.

The table shows the rate of reaction in arbitrary units for the different temperatures within each of these arrangements.

Based on this information, the methods must be evaluated in order to find the optimum distribution for the catalyst, making sure data is used from the table to support the answer.

This is a complex context and therefore it is important to follow the steps outlined earlier.

Tip 1: what to look for

Following the 3 steps highlighted in the extended-response question (ERQ) top tips section:

Step 1: identify the topic/content area that is being addressed

First, we need to identify the topic and content area being addressed, which in this case is catalysts and collision theory.

Step 2: identify the circumstances given in the question

Secondly the circumstances. As described above, this will be applied to the different arrangements of catalysts within the reaction chamber.

Step 3: check if there is a narrowed focus that the response should be refined to

Finally, we need to narrow the focus of our response to select the optimum distribution of the catalyst and justify any conclusions made with data from the table and any relevant knowledge.

Tip 2: start with key facts

Firstly, it is important to identify the facts that are going to be applied in this question. As mentioned previously, these facts will apply to collision theory and catalysts.

Some examples of facts that can be included from the mark scheme are:

- a catalyst is a substance that increases the rate of a chemical reaction
- a catalyst is not permanently chemically changed during the reaction
- the collision theory explains the relationship between surface area and rate of reaction
- larger surface area gives more collisions per unit time, therefore, higher rate of reaction

Tip 3: application of the key points

Next, we have to consider the application of these points.

So how does the knowledge covered, apply to this situation?

In addition, for this question, it is also important to include any relevant bits of data from the table and relevant comments on scientific methodology to support any application statements made.

Here are some examples of application statements made based on the data in the question:

- there was no reaction below 70^{o}C in any of the catalyst arrangements
- the reaction rate increased with increasing temperature after 70^{o}C with all arrangements of catalyst

- in all 3 arrangements, once the reaction had begun, the rate appeared to approximately double for every 10°C rise in temperature, up to 110°C, after this there was a much larger increase
- the rate of reaction continued to rise for every 10°C up to the maximum temperature investigated
- the rate of reaction in arrangement A was slightly higher than in B, until 120°C where B was slightly higher than A
- the rate of reaction in arrangement C was the highest of all the temperatures investigated
- arrangement C at 120°C, is the optimum of these 3 arrangements of catalyst
- arrangement B appears to be the least optimal/worst of the 3 arrangements at all temperatures except 120°C could be an outlier and could be due to experimental error
- the higher the temperature the faster the rate of reaction

Tip 4: be clear on the outcomes

Finally, we need to be clear on the outcomes of all the information that has been provided.

In this example, there needs to be clear judgement on which arrangement produced the optimal rate of reaction.

As previously referenced, it is important these judgments are justified.

Some examples of evaluations taken from the mark scheme for this question are:

- only 3 arrangements of catalyst were used, however, there may be other arrangements which would produce a higher rate
- only 1 amount of catalyst was used, a different amount may have behaved differently
- a control was not present, the investigation should have been repeated without catalyst
- the highest temperature investigated was 120°C, despite there being a significantly increased rate at 120°C in all 3 arrangements
- the optimum temperature could be higher than 120°C
- no statistical analysis has been carried out to see if the difference between the 3 arrangements is significant
- there is no investigation of the effects of changing pressure on the rate

Tip 5: proof-read

Having used the steps to formulate a coherent answer, it is important to then proofread the answer, helping to ensure no marks will be lost for poor quality of written communication (QWC).

When proofreading it is important to check:

- the answer is well structured, using keywords from the question and plain, direct language
- that grammar has been used effectively (for example, are full stops and commas in the right places?)
- that a range of appropriate technical terms have been used effectively – in this case, terms such as surface area, temperature, and rate of reaction

Extended-response question (ERQ) activity

Your turn to apply the tips to the below ERQ (answers in appendix A).

Tributyltin (TBT) is used on the hulls of ships. It is toxic to most marine life.

A biology student investigated the effects of different concentrations of TBT on the reproductive rate of dog whelks.

Dog whelks inhabit rocky seashores and feed on mussels, barnacles and limpets.

The research method is described below:

Five 50 litre glass aquariums containing sea water with different concentrations of TBT were set up next to a large window as shown in the table below:

	1	2	3	4	5
Concentration of TBT ngL^{-1}	0	3	6	9	12

10 male and 10 female whelks collected from a shore close to a busy port, were placed in each aquarium.

Each aquarium contained the same number of live mussels.

The water is collected from the same shore and is constantly filtered, aerated and maintained at 10°C.

The aquariums were inspected daily, and any hatchlings removed and counted.

The investigation ran from January 1st to December 31st in one year.

Evaluate the student's methodology to determine if this approach would produce reliable results.

Your response should demonstrate:

- reasoned judgements about the outlined methodology and/or conclusions about the effectiveness and reliability of this methodology.

[9 marks, plus 3 marks for QWC]

Answer:

Framework for extended-response questions (ERQs)

The extended-response questions (ERQs) often have 3 common formats:

1. A comparison of something for a given scenario or circumstance
2. The use or application of something for a given circumstance
3. Changing or amending something for a given circumstance

In many respects, you can consider most ERQs to be a pros and cons list, with you making the final judgement as to which approach is best with your justifications.

From reading the question you should try to identify

- the topic/subject area the question is asking about
- the conditions or specific context for this question
- the question requirements, such as a comparison of 2 techniques for a given purpose

Once the above have been identified, you should consider how you plan your answer, as the ERQs assess all 3 of the assessment objectives (AOs). Here are some of the key themes that you will need to address in the 3 AOs:

- AO1: Demonstrating knowledge and understanding
- AO2: Applying knowledge and understanding
- AO3: Analysing and evaluating information

These questions can also have marks available for the quality of written communication (QWC), so having a coherent logical structure and using appropriate punctuation and grammar will be important too.

The question will state if there are marks available for the QWC, and it is worth checking for this to ensure you do not spend too much time focusing on the structure and grammar of your answer if there are not QWC marks available.

To help with this, you may want to begin with laying out the key information to include under different headings like the example below, which should help with planning your final response.

Facts	**Application**	**Outcomes**
What are the properties, characteristics, features?	What happens to those properties, characteristics, features in the given situation?	What decisions/conclusions have been drawn with justifications?

Here is a general example of how this approach can be applied to an ERQ.

An organisation wants to be able to **condition**. They are considering adopting either

- **technique 1**
- **technique 2**

Evaluate the suitability of each approach.

Facts	**Application**	**Outcomes**
Technique 1 facts, such as • properties • characteristics • features • equipment • regulation **Technique 2** facts, such as • properties • characteristics • features • equipment • regulation	How does the **condition affect technique 1** or vice versa, such as: • will the properties have an impact? • are the features compatible for this condition? • any regulatory considerations for this condition? • any benefits and risks from the condition given? How does the **condition affect technique 2** or vice versa, such as: • will the properties have an impact? • are the features compatible for this condition? • any regulatory considerations for this condition? • any benefits and risks from the condition given?	Outline your final decision with justifications given. You may need to include the limitations of your conclusions too. For example, if there are aspects of the condition that your solution will not fully address, include your justifications as to why you believe it is still the best approach. Justifications could include: • the technique which meets most/all of the conditions given • the technique that carries the lowest risk for the condition given • the technique which provides greater flexibility/adaptability for the condition given • the technique that is more reliable and 'robust' for the condition given • the technique that will have the biggest reach or impact for the condition given • combination of both techniques with justifications given

By having an approach like this you will be able to demonstrate all 3 of the AOs, and all that would remain is to structure this information into a logical coherent answer. You should not be overly concerned if you do not have time to compose that final answer, as the maximum number of marks available for QWC is 3 marks. The examiner will also mark the table of information you have produced even if there is no structured response written. Although you will not receive the 3 marks for the QWC, it will allow for a range of marks to be achieved. For example, in a 12-mark question where 3 marks are for QWC, the table will allow you to achieve up to 9 marks. Although, achieving the full 9 marks without good flow and structure in your answer would be difficult.

Remember; there are 3 aspects to the QWC marks:

- firstly, the answer should have a good flow, an orderly structure (for example, use paragraphs) and use clear and unambiguous plain English
- secondly, spelling, punctuation and grammar are also assessed (including, correct subject-verb agreements and tense, and the correct use of commas, full stops, capital letters)
- thirdly, the key terms, so referring to the question – are there any key terms that the answer should include? Are there any additional key terms from the content area that were noted during the planning, and does the use of these key terms enhance the clarity of the sentence?

For the above example, the logical structure of flow chosen might be:

- summary of technique 1 and how it applies to the condition
- summary of technique 2 and how it applies to the condition
- compare the summaries of techniques 1 and 2 for the condition, such as their similarities and differences
- use that comparison to make the final judgement, with reasons and justifications for your conclusion

Once you have your structure or ‘flow’ decided, you should ensure you pay close attention to your spelling and grammar, and use the key terms and phrases given in the question.

Identifying the relevant knowledge and applying correctly to context

General tips

- read the question carefully:
  - read it a first time without doing anything
  - read it a second time highlighting key words or phrases
- find the command verb:
  - write in your notes, your understanding of the command verbs so you fully understand how you are going to apply the knowledge to the context
  - refer to the command verb document, follow the link to the definitions of the command verb to make sure you understand what you need to do
- write in your notes a definition of the highlighted key words/phrases – these words will stand out as key knowledge areas you have learned during your qualification:
  - by writing down the definitions you could gain 'easy knowledge' marks
  - it can also result in a more focused response
  - link your descriptions to key areas of the context in the question
  - remember to use these key words/phrases in your answer as this shows true understanding of how your answer links to the context
- often with application questions you may have to assess/evaluate:
  - you have identified and defined your key knowledge areas
  - you need to acknowledge the strengths and weaknesses of each area
  - whether this knowledge area has pros and cons in itself and has a negative or positive effect on the context
- in extended-response questions (ERQs) you may need to make a supported judgement:
  - you weigh up your evaluation points and come to a decision as to which has the most important impact on the context, with strong reasoning behind your answer
  - then link those judgements to how they will impact the given context

Applying knowledge to contexts in science

Let us use the example from the ERQ activity.

Tributyltin (TBT) is used on the hulls of ships. It is toxic to most marine life.

A biology student investigated the effects of different concentrations of TBT on the reproductive rate of dog whelks.

Dog whelks inhabit rocky seashores and feed on mussels, barnacles and limpets.

The research method is described below:

Five 50 litre glass aquariums containing sea water with different concentrations of TBT were set up next to a large window as shown in the table below:

	1	2	3	4	5
Concentration of TBT ngL^{-1}	0	3	6	9	12

10 male and 10 female whelks collected from a shore close to a busy port, were placed in each aquarium.

Each aquarium contained the same number of live mussels.

The water is collected from the same shore and is constantly filtered, aerated and maintained at 10°C.

The aquariums were inspected daily, and any hatchlings removed and counted.

The investigation ran from January 1st to December 31st in one year.

Evaluate the student's methodology to determine if this approach would produce reliable results.

Your response should demonstrate:

- reasoned judgements about the outlined methodology and/or conclusions about the effectiveness and reliability of this methodology.

[9 marks, plus 3 marks for QWC]

Step 1

Read the question twice – the second time highlighting key words and phrases. They have been highlighted on the question above in green to get you started.

Step 2

Now you need to define the command words (in yellow), so you know what you need to do to each component of the key word/phrase.

Step 3

Now you need to describe the key words/phrases and apply it to the context of the question. In this scenario the key words/phrases are not explicitly labelled. Therefore, you need to identify that it is a research scenario and think of the key components of research methods, such as sample size and variables. You will also find that the key words/phrases in this example also relate to the specific context of the question, which is the methodology. Below is an example to get you started:

Control variables

- description – the control variables are identified in a method and controlled so that they do not affect the dependent variable
- apply to context (example from the question) – the water is collected from the same shore and is constantly filtered, aerated and maintained at 10^{o}C

Step 4

Now you need to evaluate each knowledge area identified in step 3. Here is an evaluation linking to the context to get you started:

- knowledge areas – control variables and temperature
- evaluation – controlling the temperature could have a negative or positive effect on the reproductive rate of dog whelks:
    - positive – the student **did** control the possible variables in each aquarium (for example, food source, temperature) and maintained them at the same level
    - negative – the student **did not** take into account the effect of artificial light in the laboratory – seasonally changing factors are reproductive triggers for many organisms, this may affect reproductive rate

Step 5

Time for a judgement – here is a judgement based on the evaluation in relation to temperature:

- as the student did not successfully create the condition of seasonal temperature changes, the significant differences between the investigation and the natural environment may invalidate all the results

Appendix A: answers to activities

English foundations activities answers

Apostrophes

Add the apostrophe	Possession/omission	Singular or plural?
My dad’s name is Amir.	Possession	Singular
Paul’s dog is very cute.	Possession	Singular
I read the research its apparently Harman’s Theory of aging.	Omission and possession	Singular
Antonio’s grandma speaks English, Italian and Arabic.	Possession	Singular
My sister’s friend is coming to visit in an hour.	Possession	Singular
I’m not sure but I think the physiotherapists are meeting next week.	Omission	Plural
The hospital’s strategy.	Possession	Singular
The Children’s Hospital	Possession	Plural
He’s the friend I spend the most time with.	Omission	Singular
That’s David’s pen, he must have forgotten it.	Omission and possession	Singular
The swimmer’s families cheered them on.	Possession	Plural

It’s or Its?

- The dog had eaten all its dinner.
- It’s been a fantastic day, she exclaimed.
- The dog licked its paw.

- Let me know when it's ready

I or me?

- Who else will be coming to the cinema with John and me?
- The children and I were sitting on the settee.

Whose or who's?

- Whose shoes are these?
- Who's left their shoes in the doorway again?
- I do not know whose number this is.
- Do you know who's singing this song?

Accept or except?

- I accept your apology.
- No dogs allowed except guide dogs.
- Everyone except the nurses need to attend.
- They do not accept credit cards in the shop.

Practice or practise?

- I am going to visit the new medical practice.
- I must practise my breathing techniques.
- On a Friday, the children practise handwriting.
- The injection is given at your doctors practice.

Affect or effect?

- Does the medication affect the symptoms of the patient?
- The new medication has no effect on his glucose.

Advise or advice?

- My advice would be to visit your GP.
- I advise that you stop smoking.
- I asked the doctor for some advice.
- Scientists advise that you wear a mask.

Allowed or aloud?

- You are not allowed in the restricted area.
- The process of learning clinical reasoning may be assisted by using think aloud.
- The patient was allowed to go home.
- She read the instructions aloud.

Word meaning

Word	Meaning	Possible example
Past	Gone in time/no longer	I often think of past holidays.
Passed	To indicate movement	Anita passed the ball to Umar.
Advice	A noun that means a suggestion about what you should do (a guide to action)	I need to get some advice about my car.
Advise	A verb that means to suggest what should be done – to recommend/give info to someone (verb)	I advise you to stay at home as the weather is poor.
Lose	Fail to win or holding on to something	I aim to lose weight.
Loose	Adjective: not tight, not attached or Verb: to free something or someone.	My dog is running loose as it escaped.
Affect	To influence something	Poverty can affect anyone.
Effect	The result – it represents the end and a good way to remember is both start with an ‘e’.	The experience has had a good effect on him.
Infer	Come to a conclusion, make an educated guess.	‘I don’t know how much you can infer from his data’.
Imply	To suggest, hint at.	She did not mean to imply that he was lying.

Tenses

1. Future, 2. present, 3. present, 4. past, 5. present, 6. past, 7. future, 8. present.

Sentences

Complex, simple, compound, compound, complex, simple.

Maths foundations activities answers

Practise rearranging formulae

1. $x = \frac{y-3}{9} + 4$
2. $4ym - t = x$
3. Rearranging gives $\frac{9}{5}\,C + 32 = F$ so, 36.2 C = 97.16 F
4. 1.41 A (Using V = IR, rearrange to give I = V/R (3.s.f.))

Working out units from formulae/calculations

1. mg/mL
2. mg/h

    *Tip: remember, ‘per’ means divide!

3. g/L

Working out formula from units

1. beats divided by minutes
2. mass divided by volume (giving an answer of 2.7 g/cm^3)
3. force x distance (giving an answer of 300 Nm)

    *Tip: remember your rules of algebra! ab = a x b

Calculating rate

1. 0.33 kg/week
2. 18 breaths/min
3. 31.25 kg/min

Practise calculating percentages

1. 258% larger
2. 3.37%

3. 24%
4. 40000%

Multiple-choice question (MCQ) in science activity answer

Answer: C. Asking consumers why they preferred one disinfectant product more than another.

Short-answer question (SAQ) in science activity answer

They should not be regarded as a biohazard (1) (assessment objective (AO1)) as they cannot infect human cells/cause infection in humans. (1) (AO2)

Accept any other suitable response.

Extended-response question (ERQ) in science activity answer

AO1 = 3 marks

AO2 = 3 marks

AO3 = 3 marks

Quality of written communication (QWC) = 3 marks

Indicative content

Indicative content reflects content-related points that a student may make but is not an exhaustive list, nor is it a model answer. Students may make all, some, or none of the points included in the indicative content, as its purpose is as a guide for the relevance and expectation of the responses. Students must be credited for any other appropriate response.

AO1 and AO2 will be implicit through the level of evaluation and reasoned judgements/and or conclusions that the learner provides.

AO1: Relevant factors/reference in evaluation and/or reasoned judgements.

Relevant factors may include:

- sample size is sufficient to enable statistical analysis
- sampling technique is appropriate
- control variables are identified and controlled
- the appropriate independent variable is identified
- the appropriate dependent variables are identified
- the use of known standards or literature reviews
- reflecting on experimental design
- the reliability of the methods

AO2: Techniques used in methodology.

- the student **did** collect the water in the aquarium from the same site as the whelks, mimicking their natural habitat
- the student **did** provide a range of concentrations of tributyltin (TBT) including an aquarium with no TBT
- the student **did** provide the whelks with a food source that they would consume in their natural habitat
- the student **did** expose the aquariums to natural light, thus creating the changing light conditions they would experience throughout the year in their natural habitat
- the student **did** conduct the investigation over one year, which is likely to allow for any seasonality in reproduction
- the student **did** inspect the aquariums daily for hatchlings which were removed and counted
- the student **did** control the possible variables in each aquarium (for example, food source, temperature) and maintained them at the same level
- the student **did not** attempt to agitate the water to mimic the wave action found in their natural habitat
- the student **did not** provide the whelks with a range of food sources they would consume in their natural habitat, which may affect reproductive rate
- the student **did not** adjust the temperature of the aquariums each month to create temperatures found in their natural habitat (seasonally changing factors are reproductive triggers for many organisms), this may affect reproductive rate
- the student **did not** provide other natural materials from their natural habitat (for example, weeds, rocks – these may be necessary as egg laying sites)
- the student **did not** take into account the effect of artificial light in the laboratory – seasonally changing factors are reproductive triggers for many organisms, this may affect reproductive rate
- the student **did not** explain how they would record their results which could affect reliability

AO3: Evaluation/reasoned judgements/conclusions.

- TBT was likely to have been in the water due to its proximity to the busy port; this would alter the TBT levels the student attempted to create and invalidate all results
- the student attempted to create some of the conditions found in the natural habitat, (natural light, mussels as food source and water from the collection point) – there were (5) more conditions that they did not create (seasonal temperature changes, range of food sources, weed, rocks, agitation to represent wave action) – the significant differences between the investigation and the natural environment may invalidate all the results
- the lack of any statistical analysis would mean that the significance of any observed differences (between the different levels of TBT) could not be judged, thus affecting the reliability of the results
- the student **did not** select a large enough sample size to ensure reliability of the results
- the student **did not** provide any data (from a literature search) to justify the concentrations of TBT they have selected, which may have all been above or below the threshold to affect reproduction – this may invalidate all results

- the student **did not** provide any data (from a literature search) on the typical reproductive rate of the dog whelk (to enable comparison), thus the student would not know if any variations (in reproductive rates) were due to the TBT concentrations or to naturally occurring variation, thus affecting the reliability of the results

Notes

Use this space to add any of your own notes or summaries