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# Making questions clear

## GCSE science exams from summer 2018

Version 2.0 September 2016

**How we write accessible questions that give students of all abilities the best opportunity to get the results they deserve.**

- GCSE Combined Science: Trilogy (double award)
- GCSE Combined Science: Synergy (double award)
- GCSE Biology
- GCSE Chemistry
- GCSE Physics

See all our specimen question papers and mark schemes at **aqa.org.uk/gcse-science**

# Contents

# Journey of a question

Creating a question paper takes a lot of time!

A question paper is put together by an exam team. The members of the team are often teachers, who have developed assessment expertise as a result of working as examiners. The team is made up of senior examiners: it includes the Chair of Examiners for the subject; a Chief Examiner for the specification; and writers for each question paper.

We also have assessment design and product teams who are responsible for managing the process and ensuring that the question paper complies with rules and regulations. The team draws on the research and assessment expertise of our Centre for Education Research and Practice: **cerp.aqa.org.uk**

We analyse the statistics of question papers sat by students. We are continuously improving: by understanding how individual questions have performed we can learn lessons which help inform any future decisions on question papers.

We develop a 'blueprint' for each question paper. This is essentially the design of the question paper, for example what areas of the specification and balance of skills are to be assessed. This is one of the most important parts of the whole process.

The exam team collaborates closely to create and then review the question paper. They scrutinise all aspects of every question.

This includes:

- relevance to specification
- breadth of specification covered
- depth of knowledge assessed
- scientific accuracy
- answers in the mark scheme accurately reflecting the question asked
- number of marks being appropriate
- level of demand
- allocation of assessment objectives
- mathematics requirements.

One area of reviewing each question encompasses 'accessibility'. We look at many elements that feed into the overall accessibility of a question. Individually these elements may sometimes not seem important but, together, the impact on the question is greater than the sum of its parts.

Accessibility is **not** about:

- 'dumbing down' our language
- tailoring our exams to less able students.

Accessibility is about getting the message across clearly without affecting the demand of the question – the content familiarity requirement is still there. Clear language and layout of question papers is important for **all** students.

To ensure that our question papers are clear to all students:

- a specialist team creates modified question papers for visually impaired students
- our question papers are also reviewed by representatives of The British Association of Teachers of the Deaf. They tell us if certain words or images could make the question more difficult for some students to access.

> Our aim is to assess the science,
> rather than making it a test of comprehension.

Our accessibility ethos gives **all** students the best opportunity to get the results they deserve.

This booklet gives 'before' and 'after' examples of questions to show how we refine accessibility.

# Our accessibility principles

To ensure we make our questions as clear as possible we review across a number of different accessibility elements.

## Question type

We use a consistent range of question types:

- closed: multiple-choice, link boxes, sentence completion, labelling diagrams
- open: labelling/drawing diagrams, short answer, calculations, extended response.

## Reading age

The different methods used to measure reading age are based on the number of words and the number of syllables per word.

Generally speaking, a question with a reading age of 16 means that an average 16-year old would score only 50% on a test of comprehension of what that question is asking. To make sure that most GCSE students will have a chance of understanding what we are asking them to do, we should be setting the reading age at about 13.

However, this is only part of the story...

One of the main issues is that the necessary scientific words of three or more syllables (such as photosynthesis, chromatography, momentum) increase the reading age.

Therefore, we take a balanced approach when ensuring the reading age is appropriate. We will reduce the reading age by carefully using 'carrier language' that supports the scientific words, and by the sentence structure. This is where accessibility fits in.

## Command words

Command words are words such as ‘describe’ and ‘explain’ that tell students how to answer a question. Each command word is part of a command sentence, such as: ‘Explain how passing an alternating current through the coil creates a sound wave’.

We use a set of command words common to all our GCSE and A-level science question papers. These can be found on our website on each specification page under ‘teaching resources’: **aqa.org.uk/gcse-science**

Command sentences are given on a separate line to the rest of the question text. Most questions use only one command word. Where two command words are needed we separate them into different sentences. Having two commands in one sentence can make it difficult for students to decipher what they must do.

## Standard wording/instructions

We will use standard wording for certain question types. This helps students gain familiarity with these questions. As a result, students will be more confident in what they need to do.

Examples:

- In multiple-choice questions we use: ‘Tick **one** box’ after the question.
- In link box questions we use: ‘Draw ***x*** line(s) from each ***y*** to ***z***’.

## Direct wording

Questions are most effective when they are short and punchy.

Command words are useful as they indicate the response required.  However, in some instances it's clearer to start questions with:

- what
- why
- when
- how
- where
- who.

For all our multiple-choice questions we use these direct question styles.

This avoids multiple-choice questions becoming unwieldy for students to grasp.

Sometimes we may just refer to picking a correct statement.

> Example:
>
> 'Which statement (about...) is true?'

The questioning words can also be combined with our command words, such as: 'Describe how' or 'Explain why'.

We don't use one-word commands such as 'Why?' or 'How?'  This avoids testing comprehension by unnecessarily asking students to link back to previous information.

## Repeated information

We try not to add unnecessary words to a question. One way of doing this is by avoiding repetition.

A common way information can be repeated is by describing a graph in the stem of the question where it is just as clear to interpret the same information from the graph itself.

Example:

'**Figure 1** shows the population of the red kite in the UK from 1950 to 2010.'

It's likely the figure for this example will clearly show population, red kite, UK, and the dates. Therefore there's no need to introduce them in a statement before the figure.

Sometimes we'll just say: 'Look at **Table 1**/**Figure 1**.', where there is no need to increase the number of words on the page with more detail.

This doesn't mean we completely abolish where information is in two places! Sometimes it's useful to repeat key bits of information to help focus a student's thinking.

## Layout/spacing

We allow for sufficient 'white space' on the page. This 'cleaner' look is a visual aid to help with readability.

Within a block of information there are often different groups of information. Where this happens we space the text so the different groups of information are clear.

## Answer line prompts

We often use answer line prompts. These make the question more accessible by taking information already given in the question to help students structure their answer.

These prompts don't give students any extra clues. They emphasise information given in the question.

Also, using prompts doesn't disadvantage students if they put all of their answer in one line. Examiners will mark all work they see (unless it's been crossed out).

The most common answer line prompt we use is numbering the answer lines. This is to reaffirm the number of responses needed.

Example:

Coal is a non-renewable energy resource.

Name **two other** non-renewable energy resources.

**[2 marks]**

1 _____

2 _____

## Sentence length

It is preferable to aim for **fewer than 20 words per sentence**. Sentences longer than this will often have various 'strands' of information and will lose their meaning.

Sticking to fewer than 20 words keeps the information concise, direct and easy to understand.

## Bullet lists

Bullets are excellent to use when displaying several strands of information that link to a single idea. They help to make the uptake of information easier by logically 'breaking up' information.

Putting two or more different strands of information in one sentence can be confusing. Often this is linked to sentences being too long.

Numbered lists also help in the same way. We generally use them to show steps in a process.

## Using bold

We use bold to emphasise key bits of text.

Some words are always in bold, such as when we ask for a number of responses: 'Give **two** reasons...'; or when referencing figures and tables.

Other times it could be that a certain word has significant impact on the information the question gives.

Example:

'What is the reason that the student used a **water bath** for this experiment?'

Bold can be very useful, although we use it with caution – too much bold loses its impact!

## Sub-clauses

Sub-clauses are groups of words within a sentence that cannot stand alone as an independent sentence. Although they're useful at adding in information related to the sentence, students find them very difficult to understand. We avoid sub-clauses where possible.

Example:

'Two children, **A** and **B**, are sitting on a see-saw, as shown in **Figure 1**.'

This sentence contains two sub-clauses. It can be made simpler by shortening the sentence:

'**Figure 1** shows two children sitting on a see-saw.'

And then label 'Child **A**' and 'Child **B**' on the diagram.

As well as simplifying the language, this solution also shows a neat way of reducing information that has been repeated.

Interpreting punctuation can be difficult. Therefore, where sensible, we design our wording so that we have the bare minimum punctuation, such as removing commas.

## Contractions

Students can find the use of: don't'; won't; didn't etc difficult to understand. Therefore we don't use contractions in our questions.

## Idiom, contexts and jargon

An idiom is a group of words where the meaning cannot be inferred. Understanding of idiom depends on experience: one person's idiom may be another's 'I don't know what you're talking about'!

Not all students will have the same experience. A student who has led their whole life in an inner city may never have come across something that a student from a rural area will find commonplace. So, we try to keep contexts simple and within the experience of most students.

There is a similar problem in the understanding of jargon:

- We use terms from the specification that are relevant to the topic being assessed.
- We explain any unfamiliar terms used in a question.

## Ellipsis

Understanding sentences where words are missing or implied is a high-level skill.

> Example:
>
> 'There are three main carbohydrate groups. Sugar is one of these. Name the two other groups.

Many students will not understand what they have to do – they are not able to fill in the missing words ('these': what are 'these'? 'other two groups of what'?). You need to fill in the gaps for them so they demonstrate their knowledge of carbohydrate groups.

> Example:
>
> 'There are three main carbohydrate groups. Sugar is one of these groups.
>
> Name the **two other** carbohydrate groups.'

This question is now much improved. Inevitably the number of words to read is increased, but the repetition helps the student understand what is required.

Also see how:

- bold is used to emphasise what the question is asking for
- spacing is used to separate the command.

## Diagrams

Diagrams must be simple, clear and have purpose.

They are great at helping to communicate ideas to students. We ensure that they provide only the information required to answer a question. Diagrams that are not relevant to the question can cloud a student's judgement.

Also, we won't have photos in simply because they look nice or break up some text! We only use photographs that have high print quality.

## Graphs

We use a variety of graphs to test a range of skills covering all levels of demand.

To ensure our graphs are clear to students we follow these principles:

1. The amount of information displayed should be concise and relevant to the level being tested. For example, graphs with two *y*-axes or negative indices are limited to the higher grades.
2. Where suitable, we use simpler gridlines or no gridlines instead of standard 2 $mm^2$ grids. For example, if a question does not rely on precise graph readings there is no need to have a complex grid. This is done in GCSE Maths and improves clarity of displayed information.
3. The gridlines and axes will be extended beyond where the data is displayed. This is done in GCSE Maths and improves clarity of displayed information.

## Tables

We test a student's ability to interpret data from a table.

What we **don't** do is expect students to unnecessarily wade through a vast amount of data. This is counter-productive as it wastes a student's time during an exam and doesn't test skills appropriately.

For example, we keep the number of columns and rows to a minimum. Yet, at a sufficient amount to base questions upon.

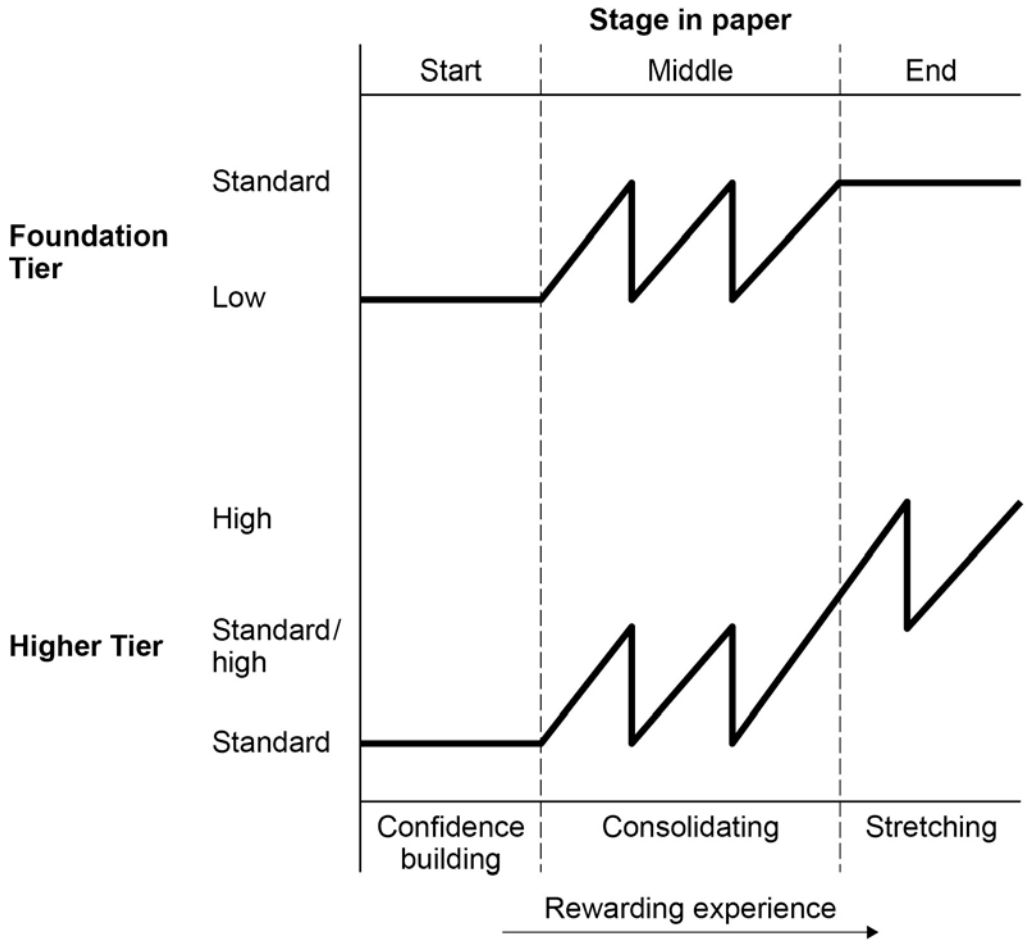
We also ensure that the content in a table matches that given elsewhere in the question. So, we'll keep to a consistent use of text given in the headings. This is also true of diagrams and graphs.

# Ramping

Ramping means that a question gets progressively more difficult as you work through it.

Questions for any topic area will be ramped in terms of demand within the question, as well as within the paper. This allows all students a fair chance of gaining some marks on each topic area throughout the paper.

Some questions will step up in demand gradually, others quite sharply. In addition the demand also increases steadily throughout the paper.




We use the model above to structure the ramping of Foundation Tier and Higher Tier question papers.

- Both tiers start with confidence-building questions set at the lowest demand for the paper: 'Low' for Foundation Tier; and 'Standard' for Higher Tier.
- The middle of each paper introduces ramping of each question up to the next level of demand. Within each question the demand increases, then the following question starts again at a lower demand.
- The end of the paper is where the students' ability is stretched the most. In the Foundation Tier this means questions are set at standard demand (common with the Higher Tier). In the Higher Tier the latter questions continue to ramp, but at a much higher level.

# Some examples

## Use of command words

This example shows two command words in one sentence. The second command 'explain' is hidden and could easily be missed by students.

As well as two command words there is a lot going on in the sentence that students have to break down to understand what's going on.

Splitting the sentence not only makes the commands and other information clearer but also puts the sentence length into an acceptable range.

In a scrapyard, an electromagnet is used to lift and release cars so they can be moved around.

Suggest **two** ways a solenoid could be made to lift and release cars in a scrapyard and explain why each suggestion would be useful.

**[4 marks]**

Two command words.

Total sentence length = 24.

In a scrapyard, an electromagnet is used to lift and release cars so they can be moved around.

Suggest **two** ways a solenoid could be made to lift and release cars in a scrapyard.

Explain why each suggestion would be useful in the scrapyard.

**[4 marks]**

Command words separated and much clearer to students.

Both are at the beginning of their sentence.

Both sentences now short and direct.

## White space

This example shows how we structure questions and make use of white space.

Steps in the process not immediately clear.

Two students investigated the effect of caffeine on reaction time.

The first student drank a cup of coffee. Another student held a ruler above the student's hand then drops the ruler. The first student must catch the ruler as quick as she can. The distance the ruler falls is recorded.

Suggest how this method could be improved to produce valid results.

[6 marks]

Dense text will put some students off.

We use Arial as a typeface.

It's a well-recognised, plain font that students find easy to read.

We use it at size 11 pt, an acceptable size for reading.

Larger font sizes are available for students who are visually impaired.

Two students investigated the effect of caffeine on reaction time.

This is the method used.

1. Student **A** drinks a cup of coffee.
2. Student **B** holds a ruler above Student **A**'s hand.
3. Student **B** drops the ruler.
4. Student **A** must catch the ruler as quickly as she can.
5. The distance the ruler falls is recorded.

The referencing of each student is made clear by naming them 'Student **A**' and Student **B**'.

This immediately makes the process clearer and takes away the ellipsis issue.

The use of bold helps differentiate clearly between the two students.

Suggest how this method could be improved to produce valid results.

**[6 marks]**

The use of bold and square brackets here makes it clear to a student the depth of response required.

We have standardised the way we write methods so that they're easier to follow.

We use:

- standard introductory wording: 'This is the method used.'
- numbered steps to show there's a process going on
- plenty of white space.

These changes make the information more direct and make it clear when referring to particular steps of the method in a question.

# Simplifying graphs

We use a default 2 $mm^2$ grid for our graphs. However, this example shows how there's no need to stick to the 2 $mm^2$ grid if unnecessary.

**Figure 1** and **Figure 2** show how the moose population and the wolf population changed in one area.

**Figure 1**

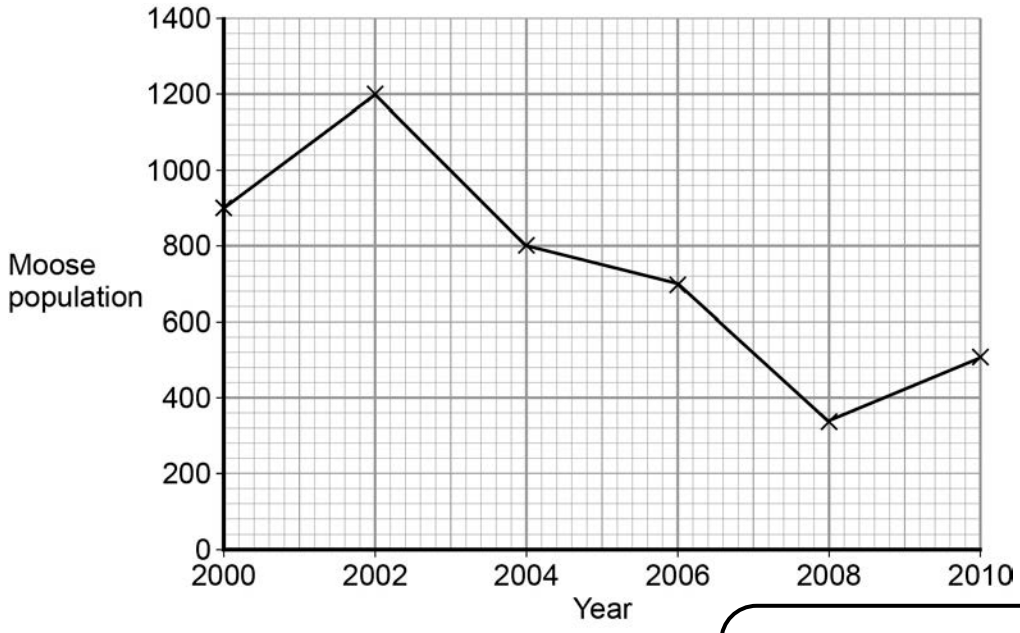
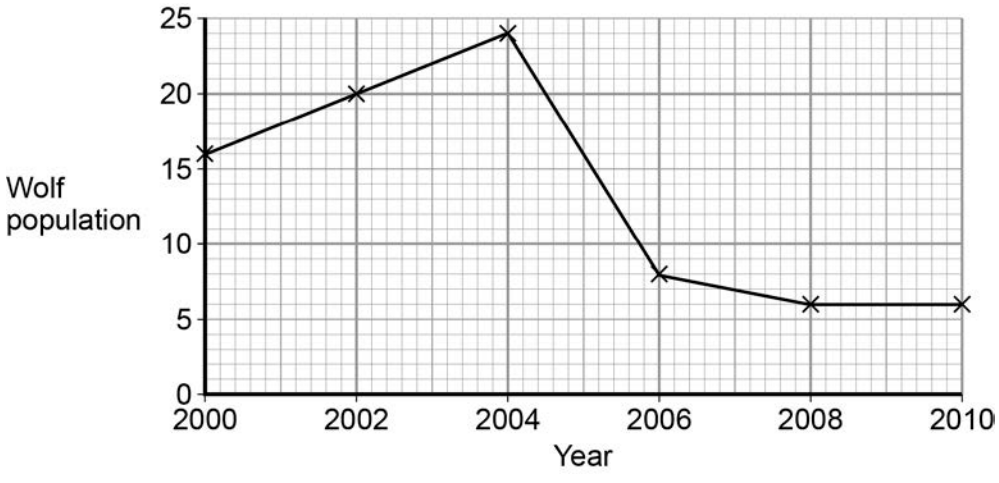



**Figure 2**



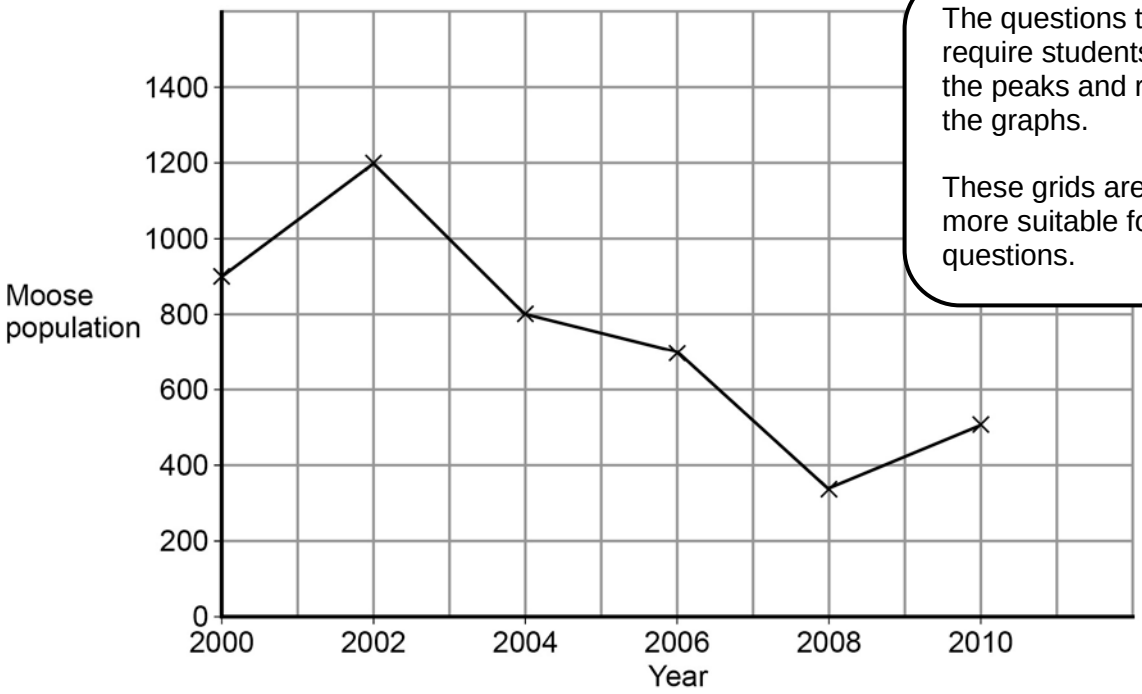

The grids given are far too detailed for the questions that follow.

It could be misleading.

**Figure 1** and **Figure 2** show how the moose population and the wolf population changed in one area.

The fewer gridlines can benefit students who are visually impaired.

**Figure 1**



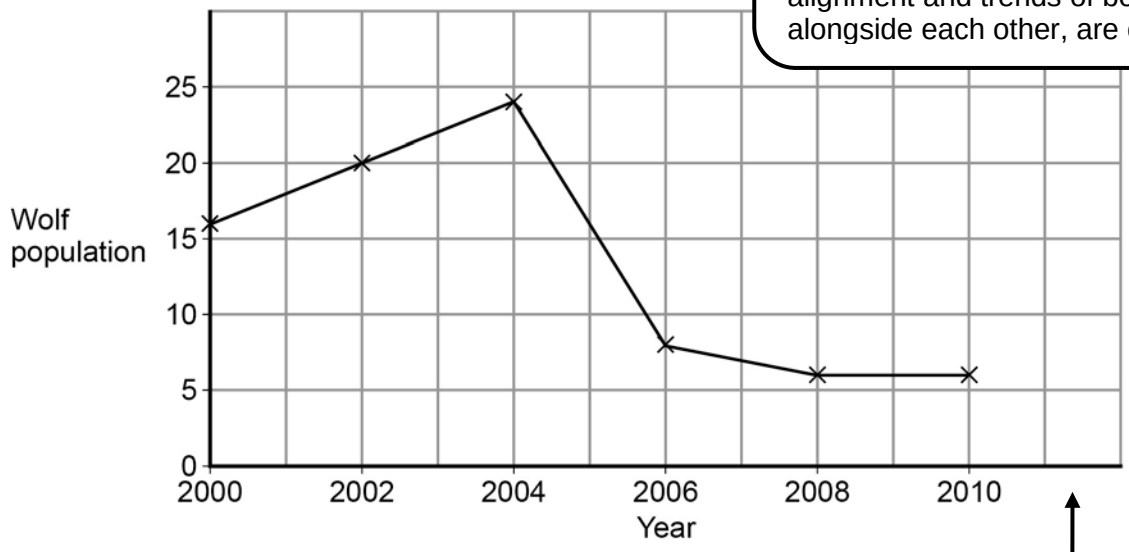

The questions that follow require students to recognise the peaks and read data from the graphs.

These grids are now much more suitable for these questions.

The years on the *x*-axes of the graphs need to align with each other.

By reducing the number of gridlines, this alignment and trends of both graphs alongside each other, are clearer.

**Figure 2**




Also see how extra space has been given around the graph data.

This improves the clarity of displayed information, especially in graphs where a 2 $mm^2$ grid is used.

## Clarity of information

This question exemplifies how important the structure of a question is.

There's a lot of information here that students need to extract and use in their answer. As it stands, it could be very difficult for students to identify the different strands of information to answer the question.

The percentage atom economy for a reaction is calculated using:

$$\frac{\text{relative formula mass of desired product from equation}}{\text{sum of relative formula masses of all reactants from equation}} \times 100$$

The equation for the reaction of copper carbonate and sulfuric acid is: $CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$

Relative formula masses: $CuCO_3 = 123.5$; $H_2SO_4 = 98$; $CuSO_4 = 159.5$

Calculate the percentage atom economy for making copper sulfate from copper carbonate.

**[3 marks]**

This dense mix of text, which includes equations and chemical symbols, is immediately off-putting to read.

This sole word that has carried over from the previous line could be missed.

The percentage atom economy for a reaction is calculated using:

$$\frac{\text{relative formula mass of desired product from equation}}{\text{sum of relative formula masses of all reactants from equation}} \times 100$$

The equations are aligned centrally to make them more distinctive.

'copper' has been moved from previous line to reduce likelihood of 'carbonate' being

The equation for the reaction of copper carbonate and sulfuric acid is:

$$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$$

Relative formula masses: $CuCO_3 = 123.5$; $H_2SO_4 = 98$; $CuSO_4 = 159.5$

Calculate the percentage atom economy for making copper sulfate from copper carbonate.

**[3 marks]**

Ample white space given to help readability.

Different strands of information are separated to make it clearer to students:

1. calculation
2. symbol equation
3. relative formula masses
4. command.

Atom economy = _____ %

Answer line prompt given.

This takes information already given in the command: 'atom economy' and 'percentage'. It guides students further.

Also, it helps make the answer clearer to examiners. Although, a correct answer given elsewhere if not given on the final answer line will be given full credit.

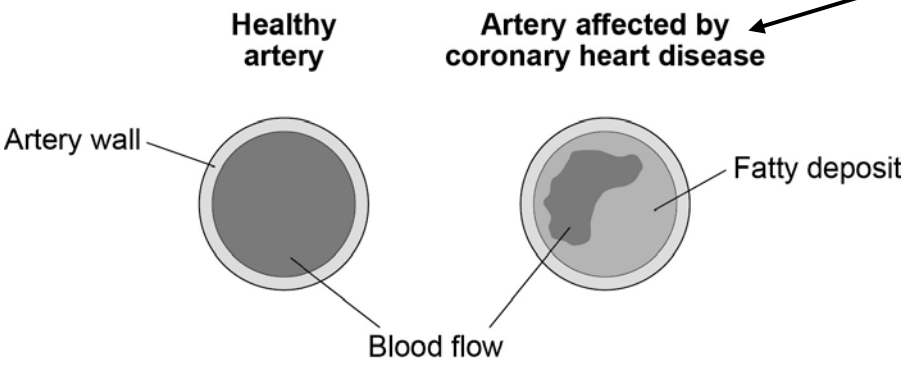
## Relevant information only

This example shows where information relating to a diagram has been stripped back.

The heart is supplied with blood by the coronary arteries.

**Figure 3** shows a healthy coronary artery and a coronary artery from a person with coronary heart disease.

**Figure 3**




The introductory information to the diagram is also clearly given in the diagram.

Consequently, this increases the reading time for a student.

The coronary arteries supply blood to the heart.

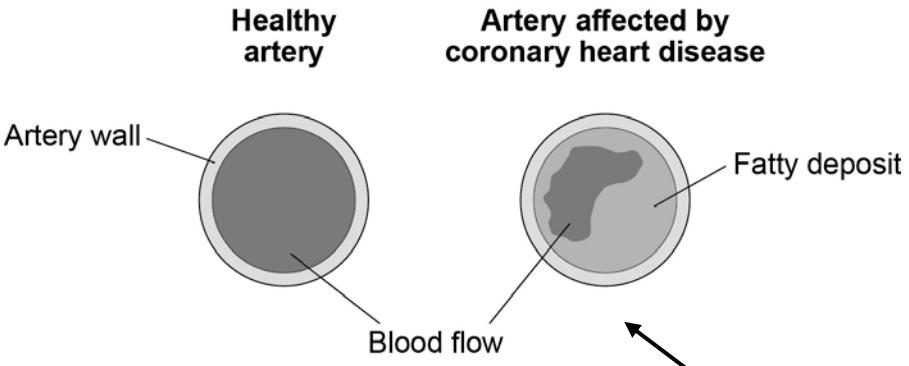
**Figure 3** shows two coronary arteries.

Sometimes we simply use: 'Look at **Figure X**.'

Surplus information on the arteries has been removed.

This immediately gives a cleaner look which helps students.

**Figure 3**




The images used are simple with clear labelling.

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