AQA
Realising potential

Focus on success: GCSE science

Disciplinary language

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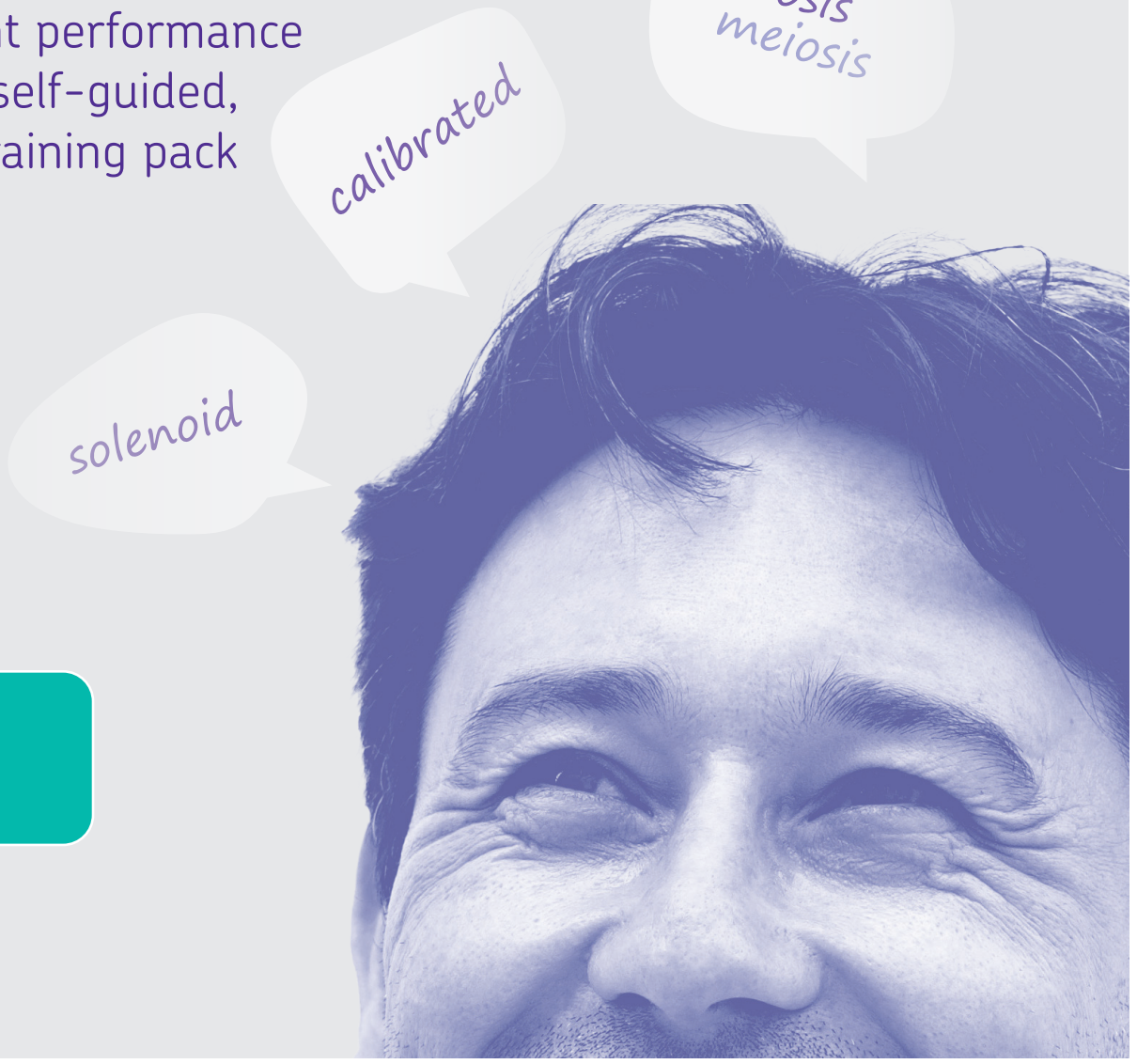

Activities booklet

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Activity 1

Activity 1a: setting the scene

- Read through slide 2, which identifies some of the challenges students face when dealing with the complexities of the disciplinary language of science.
- Thinking about your cohort of students, discuss what the particular high-level challenges your students have with:
  - the vocabulary/terms/words used by examiners in the questions
  - expressing themselves clearly in their answers.

Activity 1b: applying the research

The Education Endowment Foundation (EEF) suggests that 'literacy in secondary school must not simply be seen as a basket of general skills. Instead, it must be grounded in the specifics of each subject'.

- Consider your own school's practice concerning the teaching of literacy.
- Would you agree with this statement, and do you feel your department follows this approach?

The vocabulary of secondary school is uniquely complex because the words and phrases used in the subject disciplines are more specialist and rarer than in everyday talk and language.

The EEF refers to the model developed by Isabel Beck and colleagues presenting tiers of vocabulary. A key insight from this model is the need to explicitly teach Tier 2 and Tier 3 vocabulary which will be unfamiliar to many students.

- Consider your own department's practice. Do you explicitly teach disciplinary language and if so, when does this start to happen?

- Tier 3 words are perhaps easy to identify in science, but what sort of words would you classify as Tier 2, which need to be explicitly taught?

Activity 2

The complex nature of scientific vocabulary means that students often struggle to use words correctly in exams. There are a number of reasons for this, ranging from simply misspelling a word to misunderstanding the meaning of the word. Misconceptions held by the student can also result in them using the wrong word. It's often difficult to identify exactly why students are making mistakes, but there are patterns in errors seen on exam papers around the use of disciplinary language. To support this, we've identified two common areas where explicit teaching of vocabulary could be used to improve understanding.

Activity 2a: Words in the same topic that have different meanings

Students confuse the meanings of certain words. They're often words in the same topic area and the student hasn't clearly separated out the meaning of one word from another. Sometimes the words are antonyms (opposites) of one another. Table 1 shows some of the words that students confuse with one another.

Table 1

vaccination	antibiotics	
magnification	resolution	
gametes	ovary	testes
fertilisation	fusion	reproduction
genotype	phenotype	
biotic	abiotic	
breathing	respiration	
heat	temperature	
amplitude	wavelength	frequency
rarefaction	compression	
atom	electron	ion
bonding	structure	
evaporation	condensation	
distillation	filtration	
rate	speed	time
melt	dissolve	

In your group, discuss:

- why you think students confuse these words
- can you identify any other words that students confuse in this way?
- We've provided a dominoes activity below that you can use to explicitly teach the meanings of these words. What other resources or strategies could you develop to explicitly teach this type of vocabulary?

It can be useful to refer to the specification to see how the word is used and as a guide to the definitions that you give to your students. For example, the sentences in the dominoes are taken from the specification and would need editing to suit the level of the student.

Example activity: Dominoes

Match the word with the correct description

Phenotype	Gametes join at _____ to restore the normal number of chromosomes.
Fertilisation	Asexual _____ involves only one parent and no fusion of gametes. Sexual _____ involves the joining (fusion) of male and female gametes
Reproduction	Oestrogen is the main female reproductive hormone produced in the _____
Ovary	The alleles present, or _____, operate to develop characteristics that can be expressed as a phenotype.
Genotype	Testosterone is the main male reproductive hormone produced by the _____, and it stimulates sperm production
Testes	Sexual reproduction involves the joining (or _____) of male and female gametes.
Fusion	Sexual reproduction involves the joining (or fusion) of male and female _____
Gametes	Very rarely a mutation will lead to a new _____.

Activity 2b: Similar sounding and spelt words

Our science exams assess student knowledge, understanding and application of science. Although we'd prefer students to spell scientific words correctly, we do allow phonetic spelling as long as the student's meaning is clear and unless what they've written could be confused with another technical term.

Table 2 lists some of the most common Tier 3 words that students mistake for one another.

Table 2

meiosis	mitosis		
glucose	glycogen	glucagon	glycerol
antibiotics	antibodies	antitoxin	
quadrat	quadrant		
chlorine	chloride		
formula	formulation		

In groups:

- think of any other words that look/sound the same which students may confuse with one another
- discuss the particular barriers to learning and challenges to teaching the spelling of Tier 3 words in science lessons.
- Word-fills, like the one below, are one way to teach these words. How could you adapt your teaching to explicitly teach Tier 3 words?

Example activity: Word-fill

Words beginning with G:

1. _____ is a simple sugar with the molecular formula $C_6H_{12}O_6$.
2. In liver and muscle cells, excess glucose is converted to _____ for storage.
3. The pancreas produces the hormone _____ that causes glycogen to be converted into glucose.
4. Lipases break down lipids (fats) to _____ and fatty acids.

Activity 3

Precision in writing

When students explain processes and phenomena, their poor use of disciplinary language can mean that they don't access all of the marks available. This can be due to commonly held misconceptions or because they don't fully understand these complex processes and phenomena and become confused in their use of vocabulary.

Activity 3a: Misconceptions

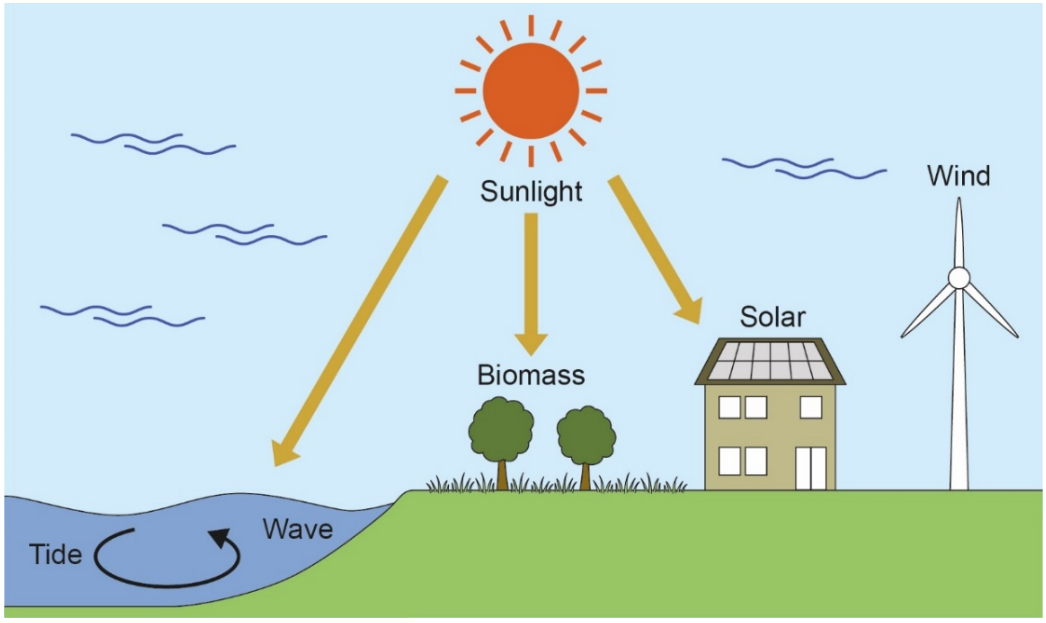
Students can have deep rooted misconceptions which, if not identified and addressed with a plausible alternative, mean they keep hold of these ideas. One very commonly held misconception, which applies across the science disciplines, is the idea that energy is 'made' or 'produced'.

- Look pages 4 and 5 in the *Appendix booklet* which show where the energy misconception can arise across all sciences. Note that links have been made between Biology content and other topics.
- In your group, can you identify some other **energy** links across the specification?
- In your group, discuss some other common misconceptions that may occur across topics.
- Below, we've illustrated one common strategy of using an image plus key words and phrases to scaffold a student's writing as a way to address a misconception. What other strategies can you use to address misconceptions like this?

Teaching strategy

Use the picture to explain three different things that happens to the Sun's energy. Use the key words/phrases to help.

- Transfer energy (or energy is transferred)
- Energy is released
- Energy is absorbed
- Provide energy (or energy is provided)



Activity 3b: Complex ideas

Students struggle to write precisely about complex ideas such as bonding. Even though they may have learnt the correct vocabulary, they may not fully understand the ideas and how things link together in a sequence. By having opportunities to logically sequence explanations using the correct disciplinary language, either written or verbally, students will be better equipped to access marks in higher tariff questions.

Look at the two student responses below, which are from the 2018 GCSE Chemistry Paper 1H.

- What are the key concepts they have muddled up and misunderstood?
- How can you identify these types of misunderstandings from the assessment materials you currently use?
- What teaching strategies can you use to break down these complex ideas and processes to help students use the correct disciplinary language and sequence their explanations?

Student A

0 7 . 3 Chlorine reacts with hydrogen to form hydrogen chloride.

Explain why hydrogen chloride is a gas at room temperature.

Answer in terms of structure and bonding.

[3 marks]

The bonds are weak between hydrogen and chlorine meaning less energy is needed to break down the bonds. Therefore it will have a low boiling point and melting point.

Student B

→ liquid ↗ gas HCl

0 7 . 3 Chlorine reacts with hydrogen to form hydrogen chloride.

Explain why hydrogen chloride is a gas at room temperature.

Answer in terms of structure and bonding.

[3 marks]

It is a gas at room temperature as it has a low melting and boiling point. Simple molecular covalent structures have weak inter molecular forces meaning that it is easy to break the bonds. They share 1 pair of electrons.

Mark scheme

07.3	hydrogen chloride is made of small molecules (so) weak forces between molecules (which) require little energy to overcome	allow hydrogen chloride has covalent bonding do **not** accept reference to bonds breaking

Activity 4

The language of working scientifically

The working scientifically language can be challenging for students to understand and apply as many of the words are not in their everyday vocabulary. Some, like 'resolution', are infrequently used even in their science lessons. Words like 'accuracy' and 'precision' have subtly different meanings, even to scientists.

Activity 4a

- Using Table 3 below, identify which working scientifically words your students struggle with.
- Which words are introduced and embedded at KS3?
- Referring to your scheme of work identify an order for your practical lessons where you'll:
  - introduce and explicitly explain the meaning of the word
  - have an activity to check students understanding of it
  - embed its use to reinforce the understanding
  - compare across the three sciences to check each term you have identified is covered a number of terms.

Table 3

Key word	Hard?	KS3	Key word	Hard?	KS3
Accuracy			Calibration		
Anomalies			Measurement error		
Systematic error			Random error		
Evidence			Zero error		
Hypothesis			Interval		
Precision			Range		
Repeatable			Reproducible		
Resolution			Sketch graph		
True value			Uncertainty		
Validity			Valid conclusion		
Variables			Categoric variable		
Continuous variable			Control variables		
Dependent variable			Independent variables		

Activity 4b

Using the separate *Working scientifically vocabulary* resource, discuss how you might use this with your students in:

- teaching and learning
- revision and exam preparation.

Activity 5

Understanding the command words

Below is a series of examples of student work for you to look at and discuss with colleagues. Each activity introduces the requirements of the command word and then explores your understanding of the requirements.

These are **not** exercises in allocating marks. You should be looking at how what the student has written matches the requirements of the command word; for instance, have they given an explanation or simply made a series of unconnected statements? Compare your thoughts with the examiner commentaries.

You could use these exercises with your students to help them understand what they should be doing using these particular examples, or using examples taken from your own students' work.

Activity 5a: Describe

Definition in Command words resource

Students may be asked to recall some facts, events or processes in an accurate way.

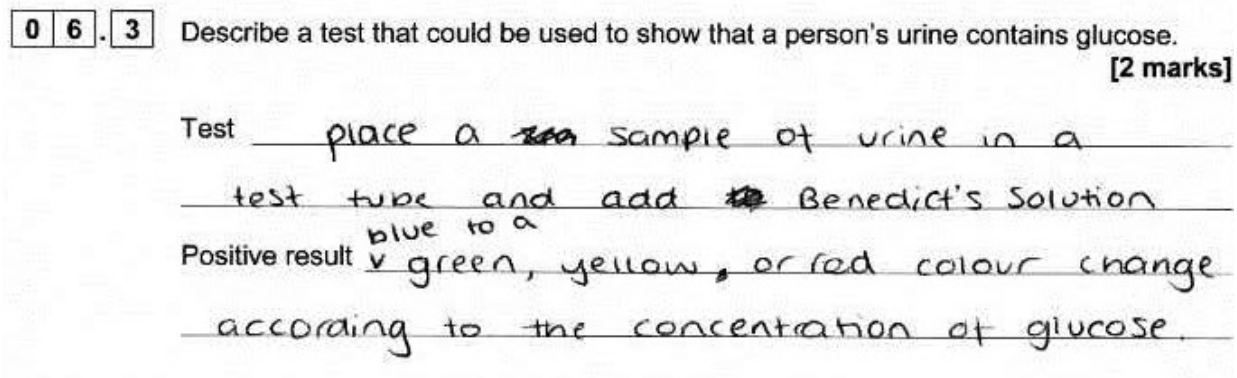
What we're looking for in assessments

Students should be using the number of marks allocated to the question as a guide to their description. For example, if they're asked to describe the trend on a graph and the question is worth two marks then they need to be writing two things they see to give a full description and gain both marks.

Exploring student responses to 'describe' questions

- Look at student response 1.
- Has the student met the requirements of the command word?
- What about their response makes you think that?

Student response 1: 2019 GCSE Biology 1H Question 6.3



0 6 . 3 Describe a test that could be used to show that a person's urine contains glucose.

[2 marks]

Test place a sample of urine in a test tube and add Benedict's solution

Positive result blue to a green, yellow, or red colour change according to the concentration of glucose.

The test for glucose is to heat the sample with Benedict's solution. If glucose is present, the solution will change from blue to brick red (orange, yellow, green or brown are also accepted colours).

Activity 5b: Explain

Definition in Command words resource

Students should make something clear or state the reasons for something happening.

What we're looking for in assessments

More depth than 'describe' is required here: the answer should not just be a simple list of reasons or points. This means that points in the answer **must be linked** coherently and logically.

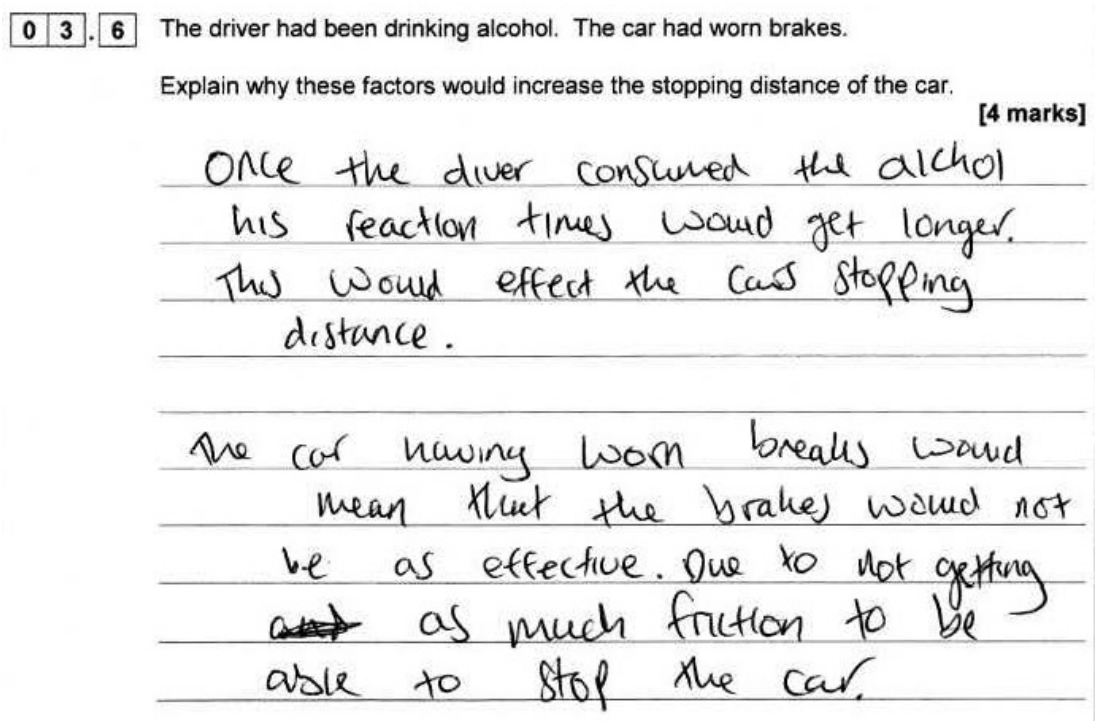
Suitable linking words in the answer could be 'so', 'therefore', 'because', 'due to', 'since', 'this means' or 'meaning that'.

'Explain' questions are always worth more than 1 mark, which should give students a clue that something more than a simple statement is required; there's likely to be a mark for stating something and mark(s) for the reasons for this.

Exploring student responses to 'explain' questions

- Look at student response 2.
- Has the student written an explanation?
- What in their language makes you think this?

Student response 2: 2019 GCSE Combined Science Synergy 3F Question 3.6



0 3 . 6 The driver had been drinking alcohol. The car had worn brakes.

Explain why these factors would increase the stopping distance of the car.

[4 marks]

Once the diver consumed the alchol his reaction times would get longer. This would effect the cars stopping distance.

The car having worn breaks would mean that the brakes would not be as effective. Due to not getting as much friction to be able to stop the car.

Activity 5c: Compare

Definition in Command words resource

This requires the student to describe the similarities and/or differences between things, not just write about one.

What we are looking for in assessments

If students are asked to 'compare X with Y', they need to write down something about X and something about Y, using comparative words such as 'better', 'more than', 'less than', 'quicker', 'more expensive,' or 'on the other hand'.

Answers need to be clearly comparative.

Often students will give a description of or a list of statements about X, followed by a description of or a list of statements about Y, without any comparative language in the answer. Such lack of clarity puts the onus on an examiner to decide whether the student is making a comparison or not. It also runs the risk of a student who clearly knows quite a lot about the subject not gaining marks because they've not made a comparison.

Exam questions often ask students to compare aspects of knowledge that may have been taught separately (eg bonding in different types of molecule; different adaptations to the environment).

Exploring student responses to 'compare' questions

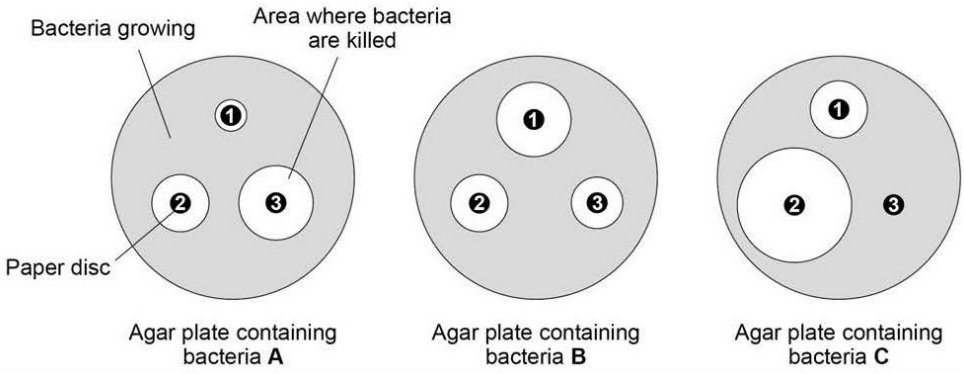
- Look at student response 3.
- This response gained full marks.
- Can you identify the features that make it a good response to the command word?

Student response 3: 2019 GCSE Biology 1F question 5.4

A scientist investigated the effect of three different antibiotics on three different types of bacteria, **A**, **B** and **C**.

Figure 9 shows the scientist's results.

Figure 9



0 5 . 4 Compare the effectiveness of the three antibiotics at killing the different types of bacteria.

[6 marks]

- Antibiotic 1 is less effective into killing bacteria A however it's more effective into killing bacteria C and even more for killing bacteria B.
- Antibiotic 2 is effective into killing bacteria A and B but is way more effective into killing bacteria C
- Antibiotic 3 is more effective into killing bacteria A more than bacteria B and C. Bacteria ~~the~~ antibiotic does not kill bacteria C.

Overall → ~~bacteria~~ Antibiotic 3 is more effective into killing bacteria A.

Question 5 continues on the next page

- Antibiotic 1 is more effective into killing bacteria B
- Antibiotic 2 is more effective into killing bacteria C.

Activity 5d: Evaluate

Definition in Command words resource

Students should use the information supplied, as well as their knowledge and understanding, to consider evidence for and against when making a judgement.

What we're looking for in assessments

An evaluation goes further than 'compare'. For example, students may be given a passage to read and told to 'evaluate the benefits of using system X and system Y'. This means they'll need to write down some of the points for and against both systems to develop an argument. They should then provide a judgement or conclusion based on the evidence they've given.

Students should consider both sides of the argument, using linking words such as 'however', 'whereas', 'but' and 'on the other hand'.

No credit is given for simply stating information given in the question, in either the comparisons or in the conclusion: students need to do something with this information.

What's often lacking in student responses to 'evaluate' questions is a judgement of any kind, which means what we're getting is really a comparison not an evaluation.

Exploring student responses to 'evaluate' questions

- Look at student responses 4 and 5, which are taken from 2019 GCSE Chemistry 1F Question 10.2
- Which of the two responses more closely meets the requirements of the command?
- What are the features of that response that make it better than the other?

Student response 4: 2019 GCSE Chemistry 1F question 10.2/1H question 3.2

Table 4 shows some properties of materials.

The materials could be used to make badminton racket frames.

Table 4

Material	Density in g/cm^3	Relative strength	Relative stiffness
Aluminium	2.7	0.3	69
Carbon nanotube	1.5	60	1000
Wood	0.71	0.1	10

Evaluate the use of the materials to make badminton racket frames.

Use **Table 1**.

[4 marks]

wood has the lowest density, at 0.71 g/cm^3, out of ~~the~~ aluminium, carbon nanotubes and wood. However, it has the smallest relative strength ~~and~~ (0.1) and the smallest relative stiffness (10). Aluminium is the most dense material at 2.7 g/cm^3. Its relative strength is not much greater then wood (0.3) and its relative stiffness is ~~69~~ 69. Aluminium is the middle ground from aluminium, wood and carbon nanotubes for the majority.

Carbon nanotubes have a density of 1.5 ~~cm~~ g/cm^3, making them not the densest material. The have a relative strength of 60 which makes them the strongest material. And it has a relative stiffness of 1000 making it the stiffest material.

Student response 5: 2019 GCSE Chemistry 1F Question 10.2

Table 4 shows some properties of materials.

The materials could be used to make badminton racket frames.

Table 4

Material	Density in g/cm^3	Relative strength	Relative stiffness
Aluminium	2.7	0.3	69
Carbon nanotube	1.5	60	1000
Wood	0.71	0.1	10

Evaluate the use of the materials to make badminton racket frames.

Use **Table 4**.

[4 marks]

Table 4 shows that wood has the lowest density which would be suitable for badminton rackets as it is light weight however it only has a relative strength of 0.1 so it would become damaged easily.

A carbon nanotube has got a density of 1.5g/cm^3 which is heavier than wood but still better than aluminium. It has also has the highest strength, so it will not break easily and has the highest relative stiffness which is the most suitable for the badminton racket.

Overall I believe carbon nanotube is the best material for badminton rackets because it is lightweight and strong.

Activity 5e: Determine

Definition in Command words resource

Students should use given data or information to obtain an answer.

What we're looking for in assessments

The command 'determine' has different requirements than the command 'calculate'. To answer a 'determine' question, students must obtain information from a table and/or a graph and then use this information to work out an answer. Depending on the level of demand, there'll be more or less prompting in the question to using the source data.

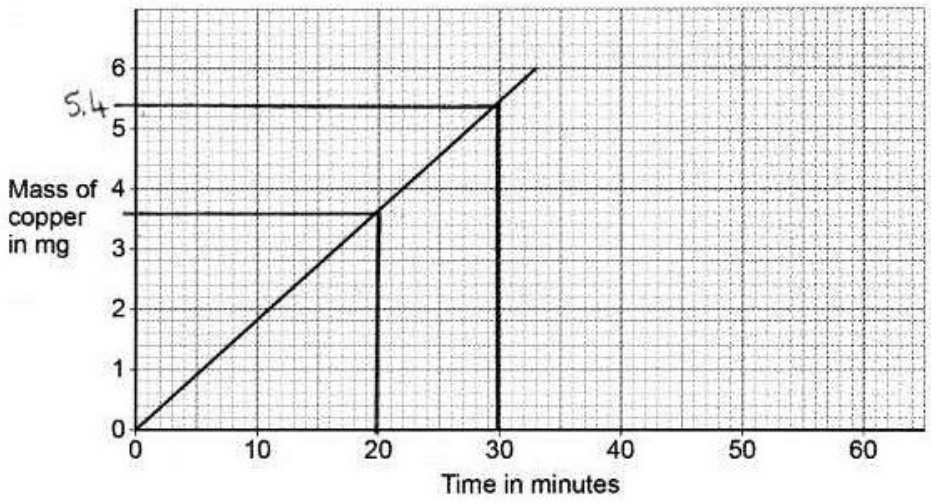
Exploring student responses to 'determine' questions

- Look at student response 6.
- To answer this question, a student needs to realise that they can't read the required value directly from the graph: they must choose a particular time on the graph (eg 30 minutes), read the mass at this time and then multiply it up correctly to give the value at 24 hours.
- This is a high-demand question and there's no indication as to the values students should be using, merely that they must use Figure 5.
- Discuss how well the student has addressed the requirements of the command word.

Student response 6: 2019 Combined Science Trilogy Chemistry 1H question 5.5

0 5 . 5 **Figure 5** shows the expected mass of copper produced each minute.

Figure 5



Determine the expected mass of copper after 24 hours.

Use **Figure 5**.

[3 marks]

30 mins = 5.4g of Cu
1 hour = 10.8g ×24
24 hours = 259.2g of Cu

Mass = 259.2 mg

Activity 5f: Suggest

Definition in Command words resource

The term is used in questions where the student has to apply their knowledge and understanding to a new situation.

What we're looking for in assessments

Students are expected to base their answers on their knowledge of scientific information or principles and there'll be **more than one correct answer**. The mark scheme will list the responses that will be accepted, with words such as 'any **two** from:', or give alternatives with '**or**'.

The context of the question is very likely to be unfamiliar to the student, but they'll be given sufficient information in the stem to help them identify which topic of the specification it's from and formulate an answer.

Useful words that students could use in responses to such questions include 'may', 'might', 'could', 'I think that …'

Exploring student responses to 'suggest' questions

- Look at student response 7
- The mark scheme is included so you can see the range of expected answers.
- This response did not gain full marks – why?
- Discuss how you could help students with such questions.

Student response 7: 2019 GCSE Physics 1H Question 8.3

A student investigated the thermal conductivity of different metals.

This is the method used:

1. Measure the mass of an ice cube.
2. Put the ice cube on a metal block which is at room temperature.
3. Measure the mass of the ice cube after one minute.
4. Repeat with other blocks of the same mass made from different metals.

0 8 . 3 Suggest **one** source of random error in the student's investigation.

[1 mark]

~~Incorrect~~ Measuring the mass of the ice cubes or metal blocks incorrectly. For ~~ex.~~ example, if ~~for to~~ the mass balance ~~was~~ did not start on zero ~~beto~~ for one of the measurements.

8.3	variation in initial mass of ice cube or surface area of the ice cube touching the metal	allow variation in initial volume of ice cube allow melting of ice while handling allow variation in room temperature allow initial temperature of metal block	1	WS3.7 4.1.2.1 AO3

Comments on student responses

Student response 1

In this type of question, if a student describes an incorrect test, they can't then give a correct description of the result because this result wouldn't be the result of the test they've described. Very often, a student will simply give a name for the test (eg 'squeaky pop test'; 'Benedict's test'), presumably assuming that this is sufficient as a description. They need to understand that, if a description is asked for, they must say how the test would be carried out, not just name it.

The student has attempted to describe the test, but has missed out an important part: the mixture needs to be heated, so they haven't given a full description. They've described the positive result clearly, which can be accepted in this case because the correct test has been described at least in part.

Student response 2

The student has used 'explain' language for both factors using suitable linking words ('This would effect …'; 'Due to …'). So they do appear to have attempted to respond to the command word.

In their first paragraph, they've made a correct statement: that alcohol increases reaction time. However, they haven't explained why increased reaction time affects stopping distance. In their second paragraph the student has given a correct statement about the brakes not being as effective due to decreased friction, but again has not explained why less effective brakes will increase the stopping distance.

So, despite their use of 'explain' language the student has **not** actually explained why the factors they've stated increase the stopping distance.

Student response 3

The student has clearly used comparative language throughout ('less effective'; 'more effective'), and referring to the data given has given clear qualitative and quantitative comparisons of all three antibiotics with all three types of bacteria.

Student response 4 and Student response 5

Student 4 has carried out a comparison of the properties of the three materials, using clear comparative language ('lowest density'; 'smallest relative strength'; 'most dense'; 'not the densest material') and making good use of the data given in the table. However, they haven't made any reference to the use of these materials in badminton rackets and they haven't made any attempt at a conclusion or opinion, so this is not a fully evaluative response.

Student 5 also compares the properties of the materials using information from the table. The language of comparison can be seen in lines 2 and 4, where they discuss the properties of wood ('lowest density'; 'only has a relative strength'). In the second paragraph, the student compares the properties of carbon nanotube with both wood and aluminium. The student links the properties of each material to its use in the racket, and rounds up their discussion with a justified conclusion ('Overall I believe carbon nanotube is the best material') in their last sentence. This answer gives enough support using the table to support the conclusion they've made and fully addresses the requirements for 'evaluate'.

Student response 6

This student has clearly understood that they need to take information from the graph and do something with it. They've drawn two lines on the graph, at 20 and 30 minutes. Both lines they have drawn back to the *y*-axis will give a value that, when multiplied up, produces the correct answer. For their calculation, they've chosen the value for 30 minutes, correctly read from the *y*-axis and correctly multiplied up to 24 hours.

Student response 7

In this response, the student has suggested measuring mistakes (measuring incorrectly), giving an example of a zero error (non-zero balance) for the second part. The student has written about variations in making measurements of the ice blocks rather than variations in the ice blocks themselves, so it's not clear if they understand that the ice blocks might not be identical.

Notes

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