Pearson Edexcel

GCSE (9-1) Sciences

Guidance for Extended Open Response questions

Guidance for Extended Open Response (6 mark) questions

Introduction

This guidance is designed to help tackle Extended Open Response (EOR) questions (6-mark questions) within Pearson Edexcel GCSE 9–1 Science exam papers. The EOR questions are designed to assess the whole grade range within the paper to allow for differentiation of candidates and for them to construct clear, sustained lines of reasoning by addressing the content and context of the question presented. In other words, students should be able to articulate a response that is coherent in linking ideas/concepts by being able to draw on and infer from information provided to analyse, evaluate and make judgments.

This guidance document will aim to help support teaching, learning and assessment around EOR questions by covering the following areas:

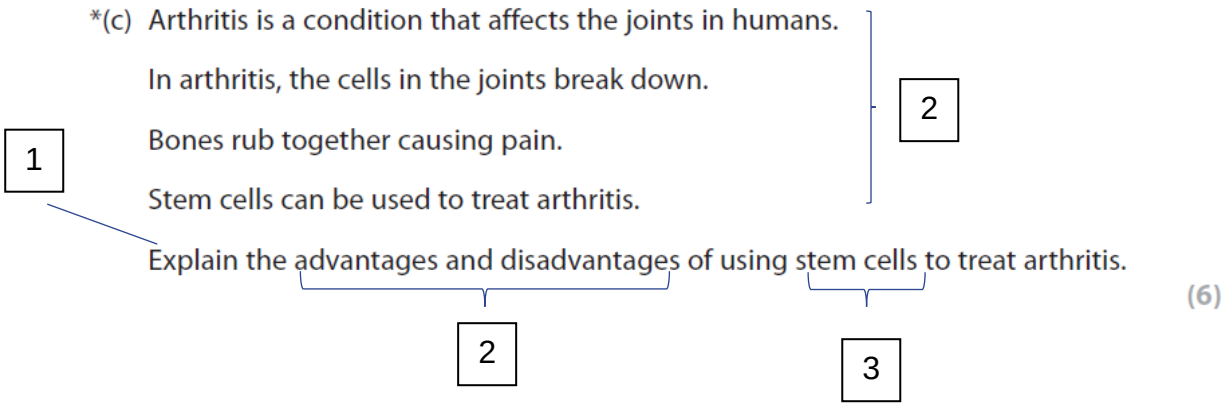
- **Key features of an EOR question and mark scheme;** so that students can become familiar with the layout, structure and location of these questions in the papers
- **How to apply marks to an EOR question;** including how best to use the mark scheme in terms of the indicative content and levelled based descriptors
- **Example student responses from June 2018 papers;** this will include examiner commentary around specific 6-mark questions, as well as tips for marking
- **Teaching and learning strategies;** that can be deployed within the classroom to develop the skills needed to tackle EOR questions.

Key features of an Extended Open Response question and mark scheme

Extend open response questions are the 6-mark questions found towards the end of a paper. There is one in each Combined Science paper and two in each Separate Science paper. EOR questions can assess across the assessment objectives, AO1, AO2, AO3, or a mixture of AOs; for example, AO2/1 and AO3/1. EOR questions will generally target a maximum of two assessment objectives.

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

EOR question: key features



1. Command word: this will determine the type of response given and the candidate will need to understand the command word to then provide the appropriate response. There are different types of command words used for EOR questions including Explain, Describe, Plan/Devise, Comment on.

2. Context/Information/instruction: this may be in the form of tables or diagrams and could include data that the learner will need to use/make reference to in their response.

3. Key terminology: look out for key terms used in the question stem, these will need to be used and/or applied in some way in a learner response.

In terms of answer lines there is ample amount of space for students to write their response, remember that not all answer lines need to be filled to demonstrate understanding, learners can also write more if they wish to.

Mark scheme: key features

EOR questions are marked using a levels-based mark scheme, which covers three sections:

- indicative content
- level descriptors
- additional guidance.

Indicative content

The indicative content lists the material from the specification that the examiners consider could be reasonably used to answer the question. It is important to note that the candidates could use other, relevant, correct science, and that this would be credited. It is also not expected that all of the indicative content be used. It is simply a list of the sort of material that could be used in an answer. The indicative content reflects the assessment objective profile of the question. If the EOR question is targeting two AOs, then the indicative content will be split under each heading.

This is an example of indicative content related to the question above

Question number	Indicative content	Mark
*9(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are therefore not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. A02(1) 6 marks Advantages • stem cells are undifferentiated/unspecialised • can differentiate into different types of body cell • cells can be used to replace damaged cells in joints • reduce symptoms/ reduced pain • less drug treatment • less chance of rejection if the stem cells are taken from the patient Disadvantages • unknown effects on the body • stem cells can divide unlimited times • risk of tumours developing • cells could differentiate into the wrong type of cell • chance of rejection if not taken from the patient's own body • research is done on stem cells taken from embryos	(6)

Level-based descriptors

The level descriptors are generic across all sciences and indicate the quality/ depth of answer needed to reach Level 1 (1–2 marks), Level 2 (3–4 marks) or Level 3 (5–6 marks).

Each question will cover one or two Assessment Objectives (AO), and these will be reflected in the level descriptors.

Remember that there are three Assessment Objectives used in GCSE science and a mixture of these will be assessed within an EOR question:

AO1: *Demonstrating knowledge and understanding of scientific ideas, and scientific techniques and procedures.*

AO2: *Applying knowledge and understanding of scientific ideas, and scientific enquiry, techniques and procedures.*

AO3: *Analysing information and ideas to interpret, evaluate, make judgements and draw conclusions, and develop and improve experimental procedures.*

This is an example of a level descriptor for the question above

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1-2	• The explanation attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3-4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5-6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Additional guidance

The mark scheme may also have additional guidance that will exemplify how the level descriptors apply in practice to the specific question. This is developed after a sample of actual candidate responses has been looked at. From January 2019, all of our mark schemes for additional sample materials and live papers will contain 'additional information', which will provide guidance on what is required at each level to help place the answer in the correct level.

This is an example of the type of additional guidance provided with each EOR question

Level 1	1–2	• A brief explanation of some advantages OR a brief explanation of some disadvantages. • The indicative content is a coherent statement.
Level 2	3–4	• A detailed explanation of some advantages OR a detailed explanation of some disadvantages OR a brief explanation of some advantages AND a brief explanation of some disadvantages. • The indicative content is a coherent statement with logical order.
Level 3	5–6	• A detailed explanation of some advantages AND a detailed explanation of some disadvantages. • The response is clear and logically ordered without errors.

How are marks applied to an EOR question

It is worth noting that these questions are marked using a levels-based mark scheme and so a 'points scoring' approach to marking is to be avoided. Remember that the marking of an EOR depends on the AO being assessed (shown on the mark scheme).

1) Start by reading through a whole response, this will give an overall feel for the best-fit level for that response.
2) To apply the mark scheme, first the level is decided. Any irrelevant information or incorrect science is ignored. However, contradictory information will be penalised.
3) Once the level is decided, the correct information and arguments are then considered. This will be a balance between the quality of the arguments and the breadth of the answer.
4) A judgement is made about the candidate's ability to construct sustained lines of reasoning for their response, and this determines whether they are given the marks at the top or the bottom of the level. It should be noted that for 6 marks, perfection is not expected. In general, for the higher marks examiners are looking for correct terminology that is used appropriately, and not mixing up the terminology. The answer should also have linkage/logical connections.

Sustained lines of reasoning

The flow of the lines of reasoning will be different, depending on the type of question.

- Where different substances/factors are being compared, the answer should flow logically from one substance/factor to the next, making sure that all substances/factors are covered. The answer should include all relevant scientific theory.
- Where an experiment is being described, the answer should proceed logically through the experiment, in the order that the steps would be taken carrying out the experiment. The answer should include naming all of the apparatus (so that a competent person could follow the intended method). It might also be necessary to explain how the data is analysed.
- Where a calculation is required, the steps in the calculation should be laid out clearly, and some explanation given of how or why the calculation is being done.

The next page will give you examples of student responses and commentary around EOR questions.

Example student responses from June 2018 papers

Biology examples

These two examples are from the 1Bi0/1F paper

Indicative content:

- Select variety A because it has large potatoes ;
- Select variety B because is faster growing and produces many potatoes ;

- Crossbreed variety A with variety B;
- Transfer pollen from flower of variety A to flower of variety B / ORA;

- Grow the new plants
- Select the offspring with the desired characteristics
- Repeat the process over many generations;
- until all offspring show desired characteristics;

The question requires an explanation of a process. The candidate should ensure their response has a logical order by explaining the process from start to finish.

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

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

(6) 2 Q0

To produce new potatos that are all faster growing and producing many, large potatoes is say getting a variety of only plants that are faster growing and produce many be combined it together and wait for the plants to produce if they don't produce you must keep trying until the plants produce many, large potatoes and faster growing so then you can reproduce more by thinking their genetics to produce exact variety, then it will start to generate a varieties of the same selective breeding.

This repeats the stem of the question. Candidates should avoid doing this.

This is rewardable content for the combining of plants with the beneficial characteristics.

The response is limited to level 1 as there is limited application of knowledge but was awarded 2 marks as the correct science is clearly identifiable.

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

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

(6) 4 Q06b

Both plants produces potatoes that are in good shape. Variety A has large potatoes but there are fewer potatoes and take time to grow however variety B has small potatoes but have a lot of potatoes but ~~to have~~ is faster at growing when we combine the two you will to one potato but the characteristics of both potato plant which mean they will a good amount of potato and not alot of time required.

The response is awarded level 2.
It has the idea of selecting the appropriate parent plants based on their favourable characteristics and combining the two plants. There is no reference to the technique required or repetition of the process so level 3 cannot be awarded.
The response is clear and logical, and lines of reasoning are evident so 4 marks are given.

This example is from the 1BI0/2F paper

Indicative content

Blood to machine

- kidney dialysis is used when a person's kidneys are damaged / don't remove urea from blood
- blood taken from arm / passes into the dialysis machine
- blood is separated from the dialysis solution by a (partially permeable) membrane
- blood returned to body

Unwanted substances

- toxic substances
- for example urea / alcohol
- excess ions / named ions e.g. sodium and chloride

How substances are removed from blood

- (unwanted substances) move into the dialysis fluid
- by diffusion across the membrane
- down a concentration gradient
- fresh dialysis fluid is pumped through to maintain the concentration gradient

*(c) Figure 18 shows a patient undergoing kidney dialysis.

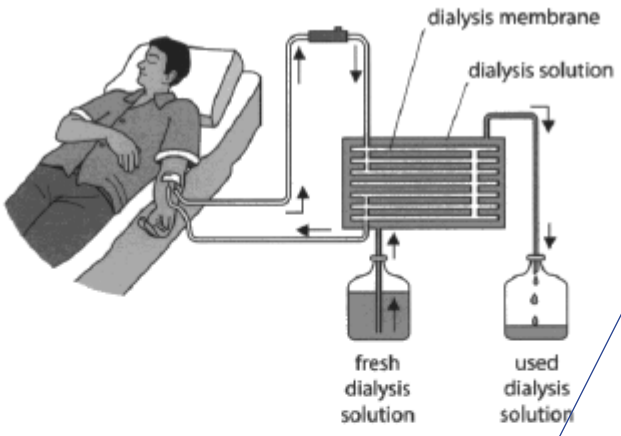


Figure 18

Describe how dialysis removes unwanted substances from the blood.

Include examples of unwanted substances in your answer.

(6) 2 Q07c

When a person is undergoing kidney dialysis, their body is being washed out of all the waste that their kidneys couldn't remove. The dialysis acts as an artificial kidney and helps the body seperate the wanted substances from the unwanted substances. Instead of allowing the body to release the unwanted substances naturally, the kidney dialysis filters it out and carries it out of the body with the use dialysis solution.

This EOR requires a description of how dialysis removes unwanted substances from the blood. It also asks for examples of unwanted substances and this would need to be included to obtain maximum marks.

This response has been awarded level 1. It has a limited description of dialysis with the idea that the dialysis machine removes the waste that the kidneys can't remove by acting as an artificial kidney. No substances are named. The response has a good structure so is awarded 2 marks.

This example is from the 1Bi0/1H paper

Indicative content

Lytic lifecycle

- viruses cannot replicate outside a host
- virus binds to host cells
- inserts genetic material into the host cell
- use the cells machinery to produce viral proteins
- use the cells machinery to produce nucleic acids
- components assemble into new viral particles
- viruses exit the cell through the host cell membrane
- or causes lysis of the host cell
- allows production of many virus particles

Spread of infection

- virus particles leave the host
- virus released into body fluids
- spread through airborne droplets/contact
- allowing spread to another host

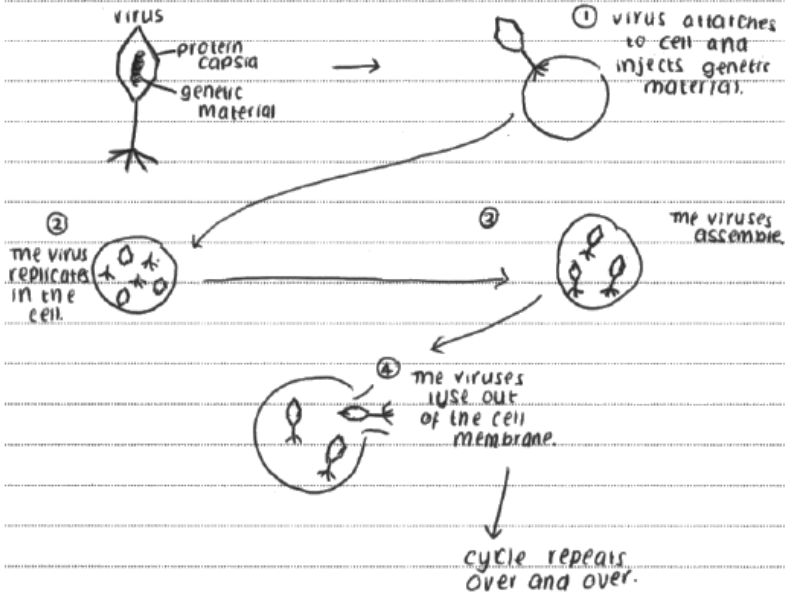
This question has two parts which both need to be addressed in the response to obtain maximum marks.

*(b) Infections can also be caused by viruses.

Describe the lytic pathway of a virus and how this causes the spread of infection through a population.

(6)

In the lytic cycle, a virus attaches to a cell and injects its genetic material. The ~~genetic material~~ virus then replicates in the cell, creating many virus organisms. The viruses then assemble and lyse out of the cell membrane to go and infect other cells.



This response has been awarded level 2. It is an excellent description of the lytic pathway of a virus and the student has used a diagram in their response. The diagram is labelled and on its own is worthy of 4 marks. The structure is clear and logical with a sustained line of reasoning. The response does not include any indicative content to describe how the virus spreads through a population so cannot be awarded level 3.

*(b) Infections can also be caused by viruses.

Describe the lytic pathway of a virus and how this causes the spread of infection through a population.

(6)

Viruses are not living and thus do not have the components needed to reproduce by themselves. For this reason, a virus injects its genetic material into a host cell and uses ~~its~~ the host cell's proteins and enzymes to create its viral components. The virus forms and this process is repeated until the cell lyses, or splits open, to release lots of viruses. This virus then goes on~~#~~ to do the same to other cells, multiplying in number. Viruses are then found in bodily fluid, such as the blood, which can be spread between people if ~~they are~~ an infected bodily fluid gets into you. This can happen if drug users share needles, or through sexual contact in some cases, like AIDS, or even a mother breastfeeding her child.

This response has been awarded level 3. It is an excellent description of the lytic pathway of a virus. It also describes how the virus is spread through the population. The structure is clear and logical with a sustained line of reasoning so is awarded 6 marks.

This question is from the 1Bi0/2H paper

Indicative content:

Transpiration
- the movement of water
- from the root through the plant
- through the lignified cells/dead cells
- of the xylem
- driven by evaporation of water from the leaves
- through the stomata
- flow is only in one direction
- by capillary action
- according to the cohesion-tension theory

Translocation
- the movement of sugars from the leaves
- through the plant
- as sucrose
- through the living sieve cells
- of the phloem
- flow is bidirectional
- to sinks in the plant where the sucrose is needed

The question requires an explanation of how substances are moved through the plant by transpiration and how substances are moved through a plant by translocation. Both would need to be included for maximum marks.

*(c) Explain how substances are moved through a plant by transpiration and translocation.

(6) 6 Q08c

Translocation happens in the phoem it transport food. It is made of elongated cells with one thick end wall. The flow of food substance (sucrose) happen in both direction and it is also an active process so it needs lots of energy. Transpiration is the transport of water and mineral ions by the xylem vessels. the flow happen only in one direction from the roots up the stem to the leaves and the emporates. It is a passive process because no energy is needed as water move to cells by Osmosis from high to low concentration. Transpiration happen by emporation and diffusion. The water loss from the leaves create a shortage in the plant so more water is drawn up. This means that transpiration is happening constantly in the plant.

Need energy because food substance (sucrose) move from high to low concentration against a concentration.

This response has been awarded level 3. The student has given a detailed explanation of both translocation and transpiration. They hit a significant amount of indicative content with the vessels, directions of transport, the substances transported and the mechanism by which it happens. The response has a well-developed structure that is clear, coherent and logical so 6 marks are awarded.

Chemistry Examples

This question is from the 1SC0/1CF paper
Level 1, 1 mark

*(d) Aluminium is extracted from its ore by electrolysis.
Iron is extracted from its ore by heating with carbon.
Both metals can also be obtained by recycling.

Explain the advantages of recycling aluminium and iron rather than extracting them from their ores.

(6) 1 Q06

By recycling alumiium and iron you are helping the enviroment, you are saving and reusing material instead of wasting it.
Also by recycling aluminum and iron we can create new things for example cars for the enviroment or electric cars or make new scientific discoverys.

In this question examiners will be looking for disadvantages of extracting metals from their ores, and then advantages of recycling. Candidates should be strongly encouraged to consider iron and aluminium separately, which should aid them in securing higher marks. One way of setting out this question is:

1. Disadvantages of extracting iron from its ore
2. Advantages of recycling iron
3. Disadvantages of extracting aluminium from its ore
4. Advantages of recycling aluminium

In the student response, vague statements such as ‘helping the environment’ will not score. The second paragraph is irrelevant (new things are made from recycled metal and from metal extracted from an ore). The only point was ‘saving material’, so 1 mark was awarded.

The following questions are from the 1SC0/1CH paper

Level 2, 3 marks

*(c) Figure 5 shows the arrangement of carbon atoms in diamond, graphene and a fullerene (C_{60}).

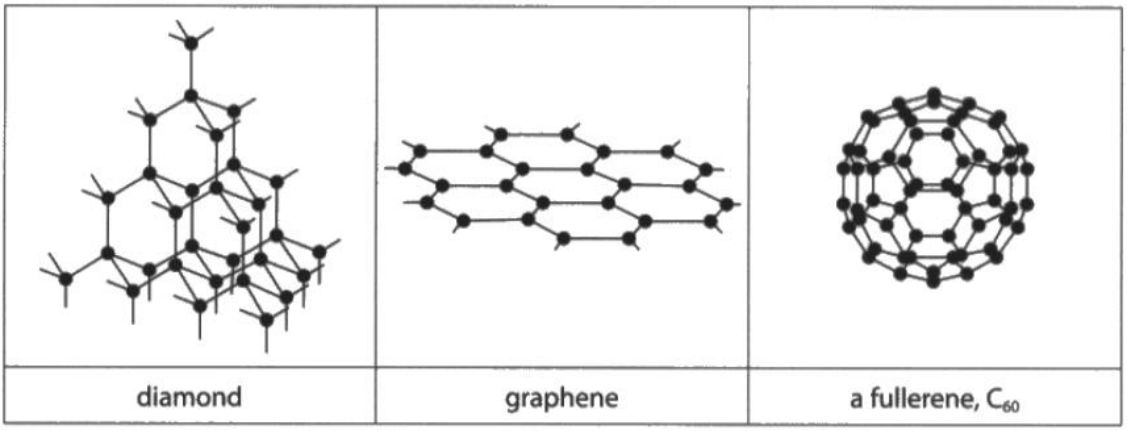


Figure 5

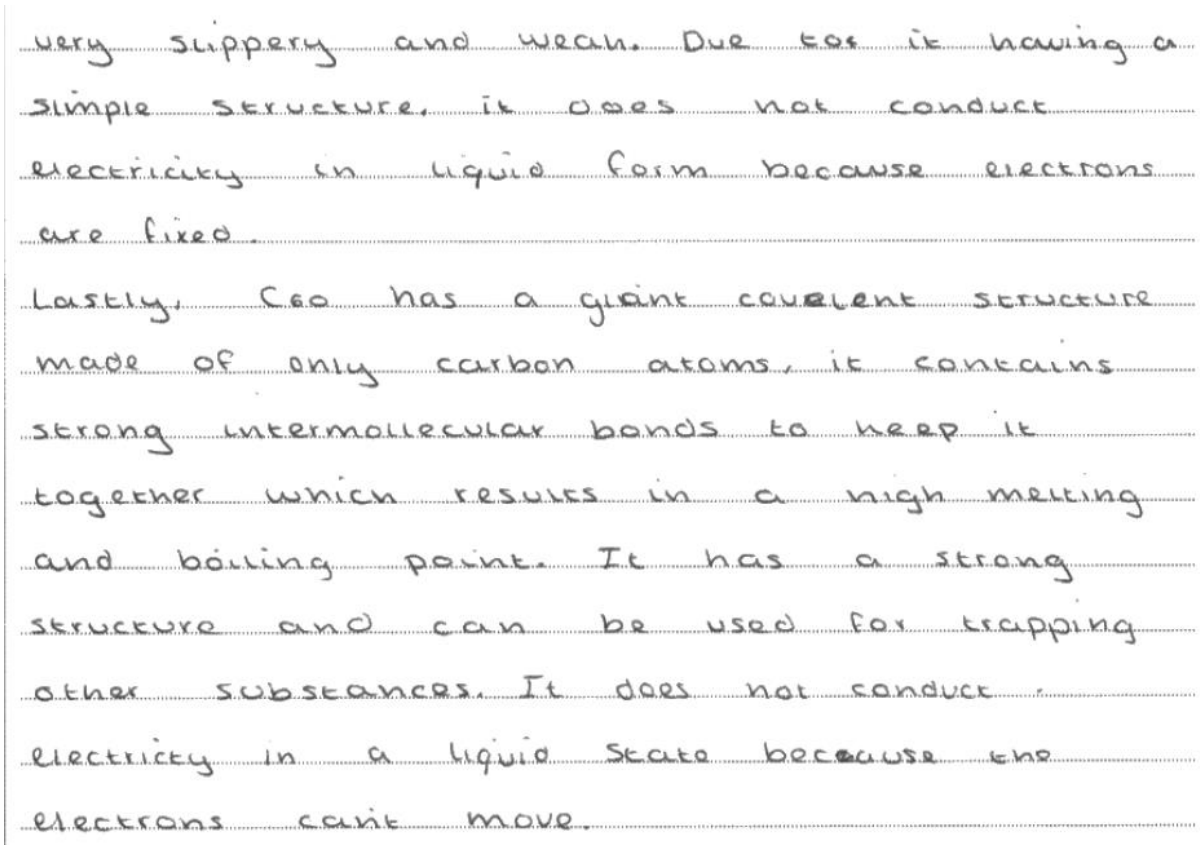
Consider these three substances.

Explain, in terms of their structures and bonding, their relative melting points, strengths and abilities to conduct electricity.

(6) 3 Q05c

Diamond has a giant covalent structure with strong intermolecular forces, this means that diamond will have a high melting and boiling point. Because of diamond's structure, it is not brittle and can be used for many tough things. It's complex molecular structure means that it does ~~not~~ conduct electricity ~~as~~ in a liquid state because the electrons will be free to move around.

Next, graphene has a simple covalent structure with weak intermolecular forces which means it has low melting points because it doesn't take a lot of energy to break the bonds. Graphene is only one atom thick so it is


very slippery and weak. Due tos it having a simple structure, it does not conduct electricity in liquid form because electrons are fixed.

Lastly, C60 has a giant covalent structure made of only carbon atoms, it contains strong intermolecular bonds to keep it together which results in a high melting and boiling point. It has a strong structure and can be used for trapping other substances. It does not conduct electricity in a liquid state because the electrons cant move.

In this example, there are three substances, and three properties to consider. The question is best answered by talking about the substances one by one. The candidate has done this. They have correctly mentioned the melting point, but have not clearly referred to strength, and the conductivity is incorrect. The explanations, in terms of structure, are wrong. For graphene, there is one relevant point only, about graphene being one atom thick. For the fullerene, again there is much incorrect material, but its poor conductivity is identified. This answer has only just reached level 2, and only because one relevant piece of information has been given about each of the substances. To get to 4 marks, or to level 3, suitable explanations would be required.

Level 2, 4 marks

(6) 4 Q05c

Diamond is held together by four very strong covalent bonds, this means it has a high melting and boiling point. It is very strong and not malleable at all. It is used to strengthen cutting tools. It can't conduct electricity because there are no free electrons and they are all strongly attracted to each other.

Graphene is also held together by three strong covalent bonds and can't conduct electricity because it has no free electrons to move each other. It has a lower boiling and melting point than diamond as it doesn't have as many bonds to hold it together.

A fullerene is also held together by three covalent bonds and it has a high boiling and melting point. They are hard to break and are used to carry drugs around the body and put them in specific places. They can form around something which makes them useful for this job. They can't conduct electricity because it has no free electrons.

All three are held together by strong covalent bonds and they have high melting and boiling points

In this example, the candidate has made a good response about diamond. For the fullerene, they have identified that it is a non-conductor, but the explanation is not correct. The information about the graphene and the fullerene is mainly incorrect/irrelevant, but it

does mention ‘three strong covalent bonds’ and the non-conductivity of the fullerene. This is enough for level 2, but linking structure and property for graphene and/or the fullerene is needed for level 3.

Level 3, 5 marks

(6) Q05(

~~Diamond~~ All 3 substances are referred to as being giant molecular structures. Diamond is made up of large areas of carbon atoms, each of which are covalently bonded to 4 other carbon atoms. This gives it very strong forces, as such means it has ~~a high~~ a high melting point because it requires a lot of heat energy to break those forces. ~~How~~ Diamond does not conduct electricity because there are no delocalised electrons available as they are all used up in bonding.

Graphene is also a giant molecular structure consisting of carbon atoms each covalently bonded to 3 other carbon atoms. It is organised in layers of these atoms, however with a layer of delocalised electrons in between. Not all electrons are used up in bonding like diamond, so the electrons form a layer as well. These electrons are free to move so graphene is able to conduct electricity. Graphene is also used as a lubricant, because it is organised in layers. This means the layers can slide over each other. *

A fullerene consists of 60 carbon atoms ~~that~~ where each carbon is covalently bonded to 3 other carbon atoms. A fullerene can conduct electricity the same way as graphene, and also has a strong melting point as well.

*Finally graphene has a ~~high~~ low melting point because the forces are not as strong so don't require as much energy heat energy to break down.

This example has a decent description of diamond. For the fullerene, the answer mentions the three carbon bonds and the lower melting point. For graphene, this is muddled with graphite, however there is still enough that is correct for this answer to be at level 3, but the errors in graphene prevent the award of 6 marks.

The following question is from the 1CH0/2H paper

Level 3, 6 marks

*(c) Two substances, **A** and **B**, each form a colourless solution.
If the solutions are mixed in a beaker, **A** and **B** react to form a coloured product.
The rate of the reaction between **A** and **B** can be investigated by placing the beaker containing the mixture on a cross on a piece of paper and timing how long it takes for enough coloured product to be produced to make the cross invisible when viewed from above, through the solution.

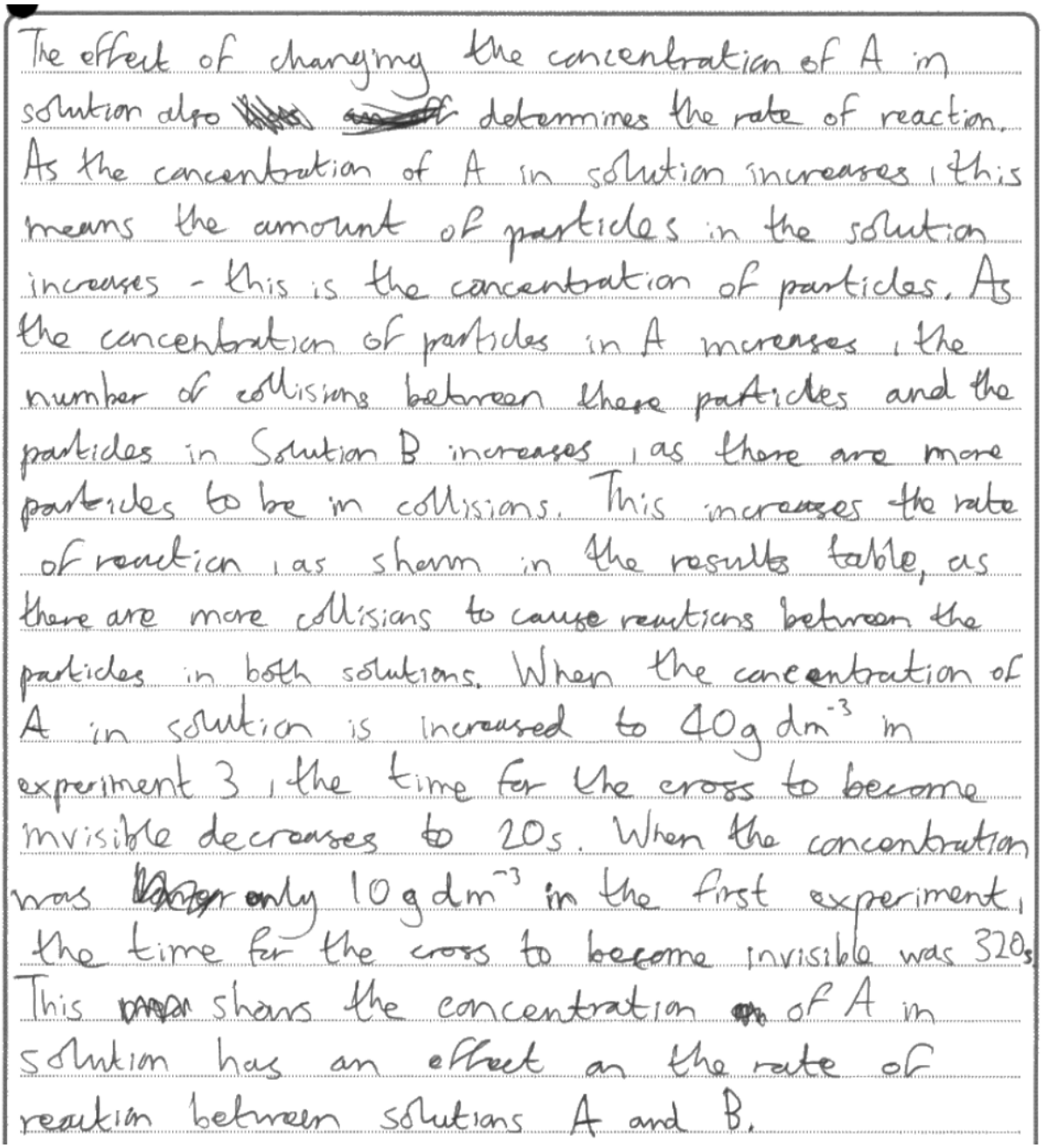
	experiment 1	experiment 2	experiment 3
concentration of **A in solution** in g dm^{-3}	10	10	40
temperature in °C	20	40	40
time for cross to become invisible in s	320	80	20

Figure 8

Use the results of these experiments to explain, in terms of the behaviour of particles, the effect of changing temperature and the effect of changing the concentration of **A** in solution on the rate of this reaction.

(6) 6 Q06c

The effect of changing the temperature has an effect on how much energy the particles in the solutions have. As the temperature increases throughout the three experiments, so does the rate of reaction. This is because increasing temperature gives the particles more energy and they have more movement, which means collisions are more frequent and there is a faster rate of reaction. This is evident in the results because when the temperature increases to 40°C, the time for the cross to become invisible is only 20 seconds, as the rate of reaction has been faster.



The effect of changing the concentration of A in solution also determines the rate of reaction. As the concentration of A in solution increases, this means the amount of particles in the solution increases - this is the concentration of particles. As the concentration of particles in A increases, the number of collisions between these particles and the particles in Solution B increases, as there are more particles to be in collisions. This increases the rate of reaction, as shown in the results table, as there are more collisions to cause reactions between the particles in both solutions. When the concentration of A in solution is increased to 40 g dm^{-3} in experiment 3, the time for the cross to become invisible decreases to 20s. When the concentration was only 10 g dm^{-3} in the first experiment, the time for the cross to become invisible was 320s. This shows the concentration of A in solution has an effect on the rate of reaction between solutions A and B.

In this question, temperature and concentration are the factors under consideration, so the answer is best organised like this. For top marks, the examiners would want to see full explanations of each factor, using collision theory, and appropriate reference to the data.

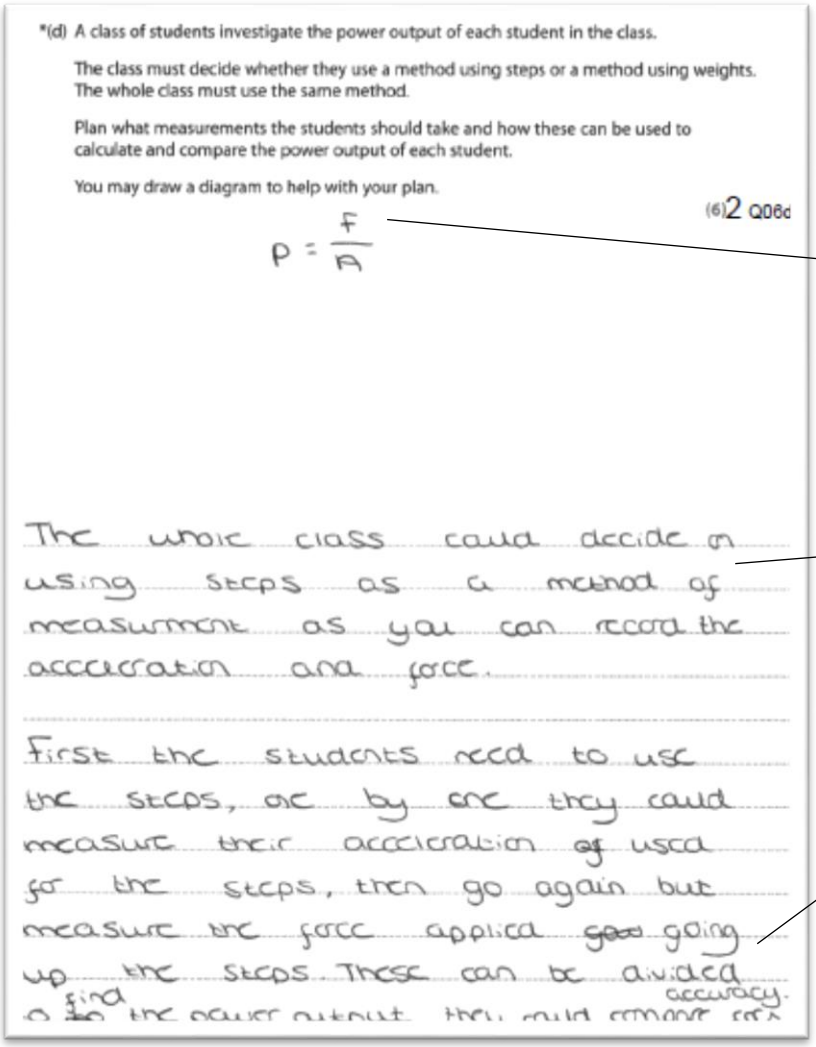
In the example, the candidate has correctly stated that more frequent collisions occur at a higher temperature, and has also linked a shorter time to faster rate of reaction. The reference to the data is not perfect, as experiments 1 and 2 should have been compared, where temperature was the only variable changing. The answer would also have been better mentioning activation energy.

In the second answer, the candidate has correctly explained why a higher concentration leads to a higher rate of reaction. Again, there is an imperfect reference to data, where experiments 2 and 3 should have been compared.

Overall, there is good use of collision theory relating to both variables, and sufficient reference to the data to be awarded level 3. This example illustrates that perfection is neither expected nor is it required – just sufficient work to show enough understanding and logical thought.

Physics Examples

The following question is from the 1SC0/2PF paper



*(d) A class of students investigate the power output of each student in the class.

The class must decide whether they use a method using steps or a method using weights. The whole class must use the same method.

Plan what measurements the students should take and how these can be used to calculate and compare the power output of each student.

You may draw a diagram to help with your plan.

(6) 2 Q06d

$P = \frac{F}{A}$

The whole class could decide on using steps as a method of measurment as you can record the acceleration and force.

First the students need to use the steps, one by one they could measure their acceleration of used for the steps, then go again but measure the force applied going up the steps These can be divided to find the power output then will compare for accuracy.

This looks like the formula for pressure rather than power and is not relevant here.

The steps method has been selected and, correctly, the need to measure force is identified. Acceleration is not relevant.

The need to measure force is restated, along with the need to compare the power of different students.

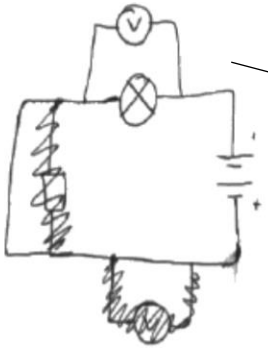
Level 1, 2 marks

This response clearly shows some understanding of the context of the question. However, only a partially correct explanation of the measurements needed is given. This response cannot be awarded a level 2 as the method suggested would not lead to a correct determination of power. Overall this is a level 1 response and 2 marks are awarded.

The following questions are from the 1SC0/2PH paper

*(b) Explain, with the aid of a circuit diagram, the method a student could use to investigate how the resistance of a single lamp changes with the potential difference across the lamp.

(6) 2 Q06b



The battery pack will start on a low voltage, and the voltmeter will be used to find the potential difference across the lamp. The voltage can then be repeatedly turned up, and the ~~voltage~~ potential difference across the lamp each time will be recorded in a table of results. The experiment should find that as the voltage increases, the potential difference across the lamp increases by less each time, because resistance also increases as voltage increases. Although the potential difference will increase each time, it will increase by less each time the voltage is increased.

Credit can be given for the circuit diagram, which correctly shows the inclusion of a voltmeter across

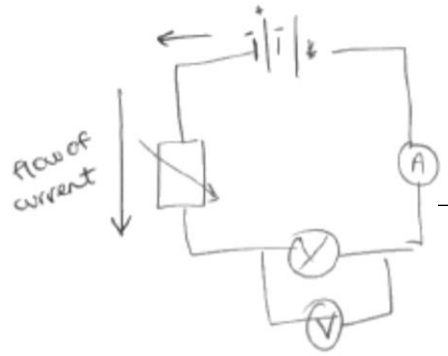
The need to vary the potential difference is correctly identified

Level 1, 2 marks

Overall it is clear that this response shows some understanding of the techniques and measurements needed to measure resistance. However, the omission of an ammeter and the confused final sentence means that insufficient data will be collected to calculate resistance. This limits the score to level 1 and 2 marks are awarded.

*(b) Explain, with the aid of a circuit diagram, the method a student could use to investigate how the resistance of a single lamp changes with the potential difference across the lamp.

(6) 4 Q08i



By setting up the experiment circuit like the one above. Then The voltmeter has to always be parrallel to the component and a ameter has to always be in series. As you increase the potential difference the resistor will also increase as they are directly proportional. So then go up in volts like 2 and record the resistance of the resistor then compare the two dates. they should see that as they increase the potential difference the resistor will increase as it will try to prevent it from blowing out.

The circuit diagram provides enough information to show that the student understands the method and measurements that need to be taken to allow resistance to be measured. Both meters are correctly positioned. This is sufficient for level 2.

The method is incomplete and not developed to suggest how the results would be used to measure resistance.

Level 2, 4 marks

The method provided is incomplete but enough information is given that would allow the collection of relevant data. Level 3 cannot be given as this is not developed sufficiently to answer the question.

The following question is from the 1SC0/1PH paper

*(b) Figure 8 shows two objects, Q and R, before and after they collide.

Figure 8

The arrows show the direction of movement of the objects.
The arrows are not to scale.

Explain how momentum is conserved in the collision.

Use Newton's third law and Newton's second law in your answer.

Newton's second law can be written as

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$ F = Ma

(6) 6 Q06b

Every action has an opposite and equal force so when Q collides with R they will both give off and equal to opposite force making Q move back as they collide and R move forward, both with the same amount of force. The force from Q colliding with R would cause R to accelerate, in relation to Newtons 2nd law of, with a greater resultant force comes acceleration. Q's energy is transferred to R in correlation to Newtons 3rd law as R is stationary so when Q collides it brings with it energy, energy of which is transferred through R causing it to move, but at the same time R gives back an equal force.

Level 3, 6 marks

The response given here is not perfect or entirely correct, but a logical and coherent answer is given that addresses the key points of the question. Understanding of Newton's first and second laws is shown. An attempt is made to link these.

Teaching and learning strategies/advice around Extended Open Response questions

Nothing beats practice, and it is suggested that after each topic is completed a 6-mark question is set. Examiners' reports give exemplars of real responses, which may be useful to instruct students.

General advice

- Read the introductory sentences carefully.
- Identify the command word being used, for example:

  - **describe** requires a description but not necessarily any justification or reasoning

  - **explain** requires that the answer is explained using appropriate science theory

  - **compare** requires the similarities and differences to be identified

  - **evaluate** requires discussion, reasoning and the drawing of a conclusion or judgement.
- Identify the key words in the question, the question will often require several aspects/substances/factors/ideas to be looked at, and these should also be identified.
- Consider the best structure for the response; for example, continuous prose, bullet points, two lists, labelled diagram.
- Write down the key words needed in the answer.
- Don't include unnecessary/irrelevant content, which could lead to errors and an answer that doesn't demonstrate a sustained line of reasoning. Remember that not all answer lines need to filled.
- Read the final answer carefully to check for errors, and that the response has actually answered the question; for example:
    - used all relevant scientific knowledge
    - used all the data given in the question
    - covered the full breadth of what is required.

Strategies that can be used in lessons

The BUG approach

- **B** – box the word which gives the type of answer required (command word)
- **U** – underline key words/instructions/information required to answer the questions
- **G** – glance back at the answer to ensure all key points are covered

For example, (6-mark practical question):

A class of students investigate the power output of each student in the class.

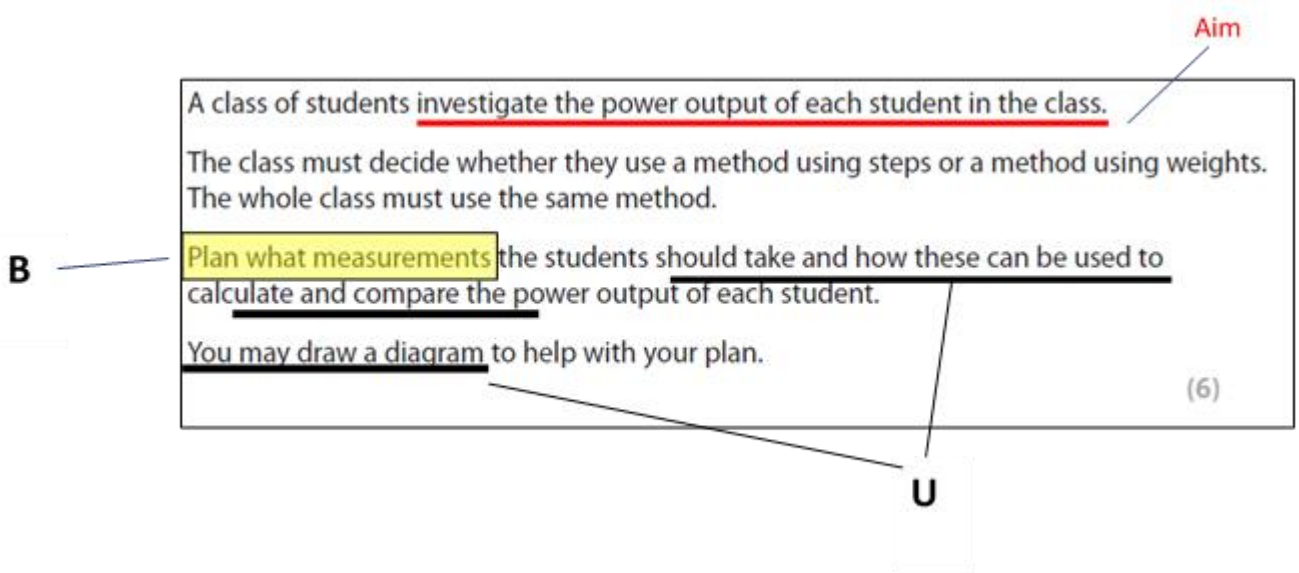
The class must decide whether they use a method using steps or a method using weights. The whole class must use the same method.

Plan what measurements the students should take and how these can be used to calculate and compare the power output of each student.

You may draw a diagram to help with your plan.

(6)

*"What is the **aim** of this experiment?"*



Using key scientific terms

Show the question and, either individually or as a group, ask students to list the key scientific terms that should be included in a response to the question. Using the key word list, they can construct a good response to the question.

Evaluation of answers

Use examples from examiners reports or ask students to answer a six-mark question on a topic they have just covered. Using a projector or visualiser, without the mark scheme, ask students to score the written response. They can mark on a printed copy where they think there is correct indicative content and where mistakes have been made. Students can then be shown the mark scheme to review their analysis. A beneficial activity to finish is to produce a model answer.

Writing a mark scheme

Mark schemes for EOR's are bullet-pointed lists of indicative content. Students can be guided to write their own mark schemes for 6-mark questions as bullet pointed lists. They can then compare their list to the published mark scheme.

Support materials

The idea of a question worth 6 marks is daunting to some students, especially when confronted with a page of lines. It is important that they recognise that they do not need to write extensive amounts to score marks on the item and that a short, well-constructed response can score maximum marks. Support materials can be used in lessons to help students build their confidence.

- Writing frames – this could be text-based, with the start of sentences given or used to highlight the different content required in the response.
- Tables that can be completed to answer the question.
- An image that shows some or all aspects of the question. This could be labelled or unlabelled.
- True and false statements related to the question. Students can select the true statements and correct the false statements so that they can be used to answer the question.

Mnemonic to help structure a response

A useful mnemonic, which may help students structure a response to a question in the context of an experimental investigation, is:

*'**W**easels **H**unt **D**reamy **R**abbits **A**ccurately'*

W	**What** quantities are you going to measure? Independent/Dependent/Control variables.
H	**How** are you going to measure it? – Name the measuring instrument.
D	Give some **detail**: • How will you use the equipment *accurately*? • How will you use the equipment *safely*?
R	**Results** analysis. Is there a formula you will use or what graph will you draw?
A	How will you ensure **accuracy** and reliability in the data collected? Repeat and average?

Further support

For any further queries please contact our dedicated Science subject advisors, Stephen Nugus or Irine Muhiuddin, on:

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