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.
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

<table>
<thead>
<tr>
<th>Level</th>
<th>Mark</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>• No awardable content</td>
</tr>
</tbody>
</table>
| 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

<table>
<thead>
<tr>
<th>Level</th>
<th>Mark</th>
<th>Descriptor</th>
</tr>
</thead>
</table>
| 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 it 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;

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

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.

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

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.

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

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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.

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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

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

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.

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 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 fluids, 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 another 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

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

Translocation happens in the phloem. It transports food. It is made of elongated cells that are thin and well. The flow of fluid substances (sucrose) happens in both directions. 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 happens only in one direction. From the roots up the stem to the leaves and the atmosphere. This is a passive process because no energy is needed as water moves to roots by osmosis from high to low concentration. Transpiration happen by evaporation and diffusion. The water loss from the leaves creates 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 substances (sucrose) move from high to low concentration. The plant uses this energy to perform various processes.
Chemistry Examples

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

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](image)

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. Its complex molecular structure means that it does not conduct electricity or 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 up a lot of energy to break the bonds. Graphene is only one atom thick so it is...
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.
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**

Diamond. All 3 substances are referred to as being giant molecular structures. Diamond is made up of large arrays 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 melting point because it requires a lot of heat energy to break these forces. Now, 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, with a layer of delocalised electrons in between. Not all electrons are used 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 agglomerated in layers. This means the layers can slide over each other.

A fullerene consists of 60 carbon atoms that are each covalently bonded to 3 other carbon atoms. A fullerene can conduct electricity to some extent as graphene, and also has a strong melting point as well.

* Finally, graphene has a high melting point because the forces are not as strong so don’t require as much 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.

<table>
<thead>
<tr>
<th>Concentration of A in solution in g dm$^{-3}$</th>
<th>Experiment 1</th>
<th>Experiment 2</th>
<th>Experiment 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature in $^\circ$C</td>
<td>20</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>time for cross to become invisible in s</td>
<td>320</td>
<td>80</td>
<td>20</td>
</tr>
</tbody>
</table>

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.

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
temperature. 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 $^\circ$C, the time for the cross to become invisible
is only 20 seconds, as the rate of reaction has
been faster.
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

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.

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 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.

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.
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

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

\[ F = \frac{\text{change in momentum}}{\text{time}} \]

**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.

“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:

‘Weasels Hunt Dreamy Rabbits Accurately’

<table>
<thead>
<tr>
<th>W</th>
<th>What quantities are you going to measure? Independent/Dependent/Control variables.</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>How are you going to measure it? – Name the measuring instrument.</td>
</tr>
</tbody>
</table>
| 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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