A-LEVEL
ENVIRONMENTAL SCIENCE

7447/1 Paper 1
Report on the Examination

7447
June 2022

Version: 1.0

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The paper was well attempted by the majority of students and it was clear centres had used the pre-release material effectively. On the whole the students had greater success on questions requiring reference to specific terminology or processes, practical questions relating to study design, and some of the levels of response items. Students generally found difficulty in questions applying mathematical skills, data interpretation and specific knowledge related to field equipment. Students are familiar with environmental terminology and use it well to describe or state process (AO1 marks). However, there is opportunity for them to develop their explanation of a process to get linked marks (AO2). A clearer structure in the paper and greater framing of questions eg such as 'explain one' or 'give two advantages' helped students provide greater focus compared to past series.

The practical questions were generally well answered, particularly those requiring study design or identification of variables. Students could improve on advantages or limitations of field equipment. While the mathematical aspects in the paper provided a challenge, it was good to see students include an attempt with worked calculations. Calculations such as percentage change and use of significant figures improved, but completing graphs (05.1) and multi-stage calculations provided difficulty. Students should be encouraged to show clearly different stages in their calculation rather than just give a final response. Students could also improve their understanding of choice in appropriate statistical techniques (09.4).

Levels of response questions discriminated well on the paper and generally quality of answers reflected overall attainment on the paper. Students should aim to identify key elements of each question and ensure they focus on all parts of the question. While there were some excellent answers across both essay topics (Water resources and Mineral resources), some lacked the scientific terminology, or a full explanation of process. We encourage students to write answers with both range and depth to achieve the higher levels. Including relevant comment linking to the question focus (eg reducing environmental impact or meeting the demands of society) also helped to ensure that students could access higher levels. It was great to see evidence of planning which often led to clear structure in students' answers.

Timing is always critical on this paper. It was evident that some students did not manage their time. Students are encouraged to attempt higher tariff questions preferentially so that they maximise their chances of accumulating marks.

Considering the challenges presented to students and the difficulties centres may have faced in preparing students for this exam, the performance on this paper was comparable with recent series and a good reflection of the preparation given by centres.

Question 1

This question discriminated well amongst the students, with more than 40% of students scoring 4 or 5 marks. Most common errors were students thinking that adsorption by polymers could control pollution or leachate collection being used to control pesticides. Many students recognised the correct mark but failed to follow the instruction of only adding one tick to each row. It is important that students follow the information in the question stem, especially if emboldened.

Question 2

02.1

This question also discriminated well and created a spread of marks. While only around 10% scored full marks, more than 40% scored at least 2. Many responses recognised thermal energy as a result of nuclear reactions and many understood that this could generate energy through turning turbines. Fewer responses recognised uranium-238 or thorium-232 as fertile fuels or recognised the creation of fissile fuels as part of the nuclear reaction. Higher scoring responses had clear order in the stages of the process and this approach is recommended in answers with multiple stages.

02.2

Approximately 40% of students scored 1 mark. The biggest error was mis-interpretation of the x-axis scale, despite interpreting the graph at the correct point of 6000 / cpm.

02.3

While the concept of half-life was understood by a majority of responses it was evident that quality of expression prevented some students from achieving this mark. Common mistakes included ‘longer to decay’ without referring to energy or radiation or without referring to rate.

02.4

Around three quarters of students correctly interpreted the figure to identify Polonium-210 as the correct named isotope. However only one third of these students could provide a reason linked to the named isotope. Common answers included ‘more ionising’ but there were many students who gave generic explanations in response to half-life, or mutations which were not relevant.

2.5

This was a well answered question with more than 40% of students scoring full marks. It was good to see the use of named processes, eg vitrification / encapsulation, relevant to managing high-level radioactive waste. Weaker answers were vague or non-specific, i.e. ‘buried in the ground’, and needed clarity eg ‘deep (geological) burial’ to receive the mark.

Question 3

03.1

This question tested two mathematical aspects, calculating percentage rise and giving the answer (in tonnes) changed to standard form and an appropriate number of significant figures. This proved to be a significant challenge for students with less than 25% scoring 1 mark. Common mistakes in

the calculation included incorrect order in multiplication / division of numerical values. Standard form was understood but incorrect answers were given as students had not transformed their answer to tonnes. Students were also unsure about significant figures. It is advisable to use the figure from the calculation to determine significant figures. In this case the value 700 meant that answer should be given to one significant figure. Although we allowed two significant figures, few students completed the calculation or transformation correctly, hence the low scoring rate on this question. Students are advised to highlight key requirements from the question stem and indicate in their answers where these are completed.

03.2

This item was well attempted by students. Students most commonly scored a mark for the change in lithospheric carbon but some found it difficult to get the mark for the biosphere and the hydrosphere. One limiting factor was the failure to include the direction of change. For example, on lithosphere if students answered 'increased fossil fuel use' they had no explained the link to lithospheric carbon i.e. had it increased or decreased? With questions asking for *change,* students are encouraged to say what the change is before they give an explanation. Other common mistakes included commenting on a change that was unrealistic in the time scale since 1850. Good answers linked biospheric carbon decreases to deforestation and increased dissolved carbon in ocean stores.

03.3

On face value this question appeared straight-forward, however, with only around 40% scoring two marks and less than 10% scoring three, this was not the case. Many could recognise the similarity between carbon capture storage and carbon sequestration as a store or reducing atmospheric carbon. Some students were a little loose with their description and did not pick up marks for 'removal of atmospheric carbon'. The question was set out for two differences. Some students chose not to use the structured format and instead wrote a description for CCS and for carbon sequestration. These were creditworthy but more of a challenge to find the comparisons. Some students were limited by not making the comparison explicit for example, they might write that carbon sequestration was a natural process but fail to comment that CCS was anthropogenic. Students should ensure their comparison comments are paired to increase their chances to achieving the mark. Most popular comparisons were the natural (CS) and man-made (CCS) or the storage in trees / oceans (CS) vs the storage in the lithosphere (CCS).

03.4

This item was well attempted, with the great majority students scoring one mark, but fewer getting a second mark. Common answers included 'afforestation' or 'increased use of renewables' as sustainable management but many only gave one of these reasons. Some were limited by quality of expression and many gave reasons such as 'reducing fossil fuels' which was not credited because it was not clear enough in terms of sustainability. A small percentage of higher scoring students recognised sustainable measures in agriculture eg reduced tillage, mulching or improving organic matter content in soil, while some referred to specific changes in diets or biodiversity management.

Question 4

04.1

Students found data response questions more challenging on the paper, and this item was a good example of this. Many could score one mark by recognising the variability in energy per unit volumes compared to energy per unit mass but few could comment on why this was more useful. Few students took the opportunity to support their answer using data from Table 4, which would have given them a second mark. Some recognised that mass was easier to measure.

04.2

Most students secured one mark here, with just less than 20% awarded 2 marks. Some students missed the point of a 'suggest' command as they struggled to think of possible reasons for the variability (without needing specific understanding of wood or straw). Common answers included potential differences in growing conditions, or variations from a range of species.

04.3

A well attempted question with many students (<70%) scoring at least one mark. Common answers included references to high productivity / quick growth rate and the growing conditions. Students did not gain credit for 'easy to grow / cheap to produce' because these answers were not specific enough. Encourage students to be specific on *why* it might be easy to grow or *why* it may have lower costing.

04.4

This was a well attempted question with a majority, around 85%, scoring one mark and around 60% a second. Many students commented on the predictability of supply rate or the ability to store. For many one of these marks was the limit of understanding. Disadvantages were more easily recognised with issues over land requirements / conflict / deforestation or the environmental impact / carbon outputs associated with production scoring the marks. Some students limited themselves by only giving one point per advantage and disadvantage. Students should be encouraged to link the number of points made with the mark tariff on describe questions.

Question 5

05.1

Plotting a graph presented a range of challenges to students which meant that only around 35% of responses scored two marks. One mark was assigned for plotting points, and this was often where the mark was scored. Students are encouraged to plot accurately, with crosses or small dots for clarity. The second mark for axis was often not achieved due to simple errors. Most common mistakes included plotting *x* and *y* scales around the wrong way (confusing dependent and independent variable), not including the units in the axis label or, most commonly, using a scale with different intervals, eg 50, 100, 150, 200, 300. Mistakes in graphical composition correlated highly with mistakes in item 5.2.

05.2

The clue to the two marks available here were the in the first five words of the question, 'use the graph to suggest'. Less than a quarter of students scored two marks because commonly they did not cover one of the aspects of the question. Using the graph needed clear reference to how heat loss varied from the plot. Many students recognised the decrease in the rate of heat loss after

100mm insulation but struggled to phrase it in a way that would score the mark, for example, heat loss increases after 100mm'. Some students did not score the second mark because they did not attempt to suggest a reason for the change in trend.

05.3
With over half of students scoring full marks, this was a well attempted response. They understood and correctly identified the economic optimum value over one year but some struggled to develop a reason why this was the case. Of those struggling many just said 'this is the point on the graph where the lines cross'. Better students recognised that this crossover represented the 'lowest overall cost' when adding annual fuel cost and insulation cost.

Question 6

06.1
With approximately 55% of students identifying the correct answer, there was good understanding of wave energy devises using gravitational energy in this multiple choice question.

06.2
More than 40% of students identified that D was the correct answer.

06.3
This question presented a challenge for the majority of students. Commonly the students could not calculate the potential maximum output in a year, 8760 MWh, using instead the value of 1MW from the question stem. This led to common answers of 0.36 (36/100). Many did not calculate the values in MWh rather just using the values given. Those that did manage to calculate the 8670 value often scored two marks with the correct calculation but lost the third mark for not giving the answer to the correct significant figures. Despite requiring one significant figure, answers were accepted at two. The third mark for a multi-stage mathematical question is often reserved for giving the answer in significant figures (or decimal places), with two marks for the calculation.

Question 7

07.1
A well answered question with two thirds of students scoring two marks. Some good answers identifying relevant variables included 'same volume of air', sampling after 'similar atmosphere conditions such as rainfall', or 'same height above the ground'. Some answers required clarity and development eg 'same time'. Some needed to be more specific and avoid stock answers like 'same time of year' which was not relevant in this case.

07.2
This question presented a challenge as just under 10% of students scored any credit. There were many generic answers such as 'device not working properly', it 'only samples a small space' or references to human error. However, the question required thought on specific limitations to capturing PM10 particles. Students should develop awareness of both the sampling and specific use of different collection devices.

07.3
This was a well interpreted question and around 60% of students scored at least one mark. Some students limited their responses by focusing only on roadside or urban. Many could recognise the reducing trend as a result of decreased use of petrol / diesel vehicles, or use of an alternative. Some gained credit through giving reference to specific technology, eg diesel particle filters or catalytic convertors. For the urban declining trend many referenced changes to renewable energy, or referenced specific change in industrial settings. Some students did not gain credit as they used the space to describe the trends or focused on small rises.

7.4
A well attempted question with around half of students scoring two marks. Students gained credit for both range and depth in their answers and it was good to see specific process knowledge and understanding to help explain why, for example, temperature inversions would lead to varying PM10 levels. Common answers focused on demand for vehicle use or use of fossil fuels while other students referred to differences after specific weather events. Some students were self-limiting by only referring to one factor.

Question 8

08.1
With approximately 60% of students scoring one mark and less than 10% scoring two it was clear that students were challenged in identifying a reason for the three-month mean. Confusion between the use of 'accurate' and 'reliable' was one of the most common limitations. Many did however recognise the need to account for natural variation. A small but significant minority recognised that the three-month period was (short) enough to analyse annual change. Often students were limited to one mark as they stated just one reason.

08.2
A well answered question with two thirds of students scoring the mark, recognising the need to ignore minor deviations.

08.3

Despite the use of an evaluation command, students performed well across this question. Of the students scoring two marks this was often a result of agreeing that El Niño had become more intense and providing data to support this. While we were looking for the answer 'little change in frequency', if students had used the figure to support their claim of increased frequency marks were given. Some students focused on the La Niña data which was a distraction. Overall around 70% of students scored two marks and around 20% scored full marks.

08.4

Just less than 80% of students correctly defined tipping points, with most commenting on the irreversible nature of them.

08.5

Students could gain credit by either commenting on positive feedback loops and developing an explanation of these (as a concern) or giving specific references to a concern eg rising sea levels, and explaining the nature of this concern. While approximately 60% scored one mark, many did

not develop their answer. Many students scored zero marks because they simply reiterated the fact that tipping points were irreversible (i.e. the answer to the previous question).

Question 9

09.1

Many gained credit for references to random / systematic sampling and some made reference to the number of samples (at least 10!). Some higher scoring students recognised the need for consistent sample sizes or sample depths. Some students were lost in the use of quadrats.

09.2

A question which discriminated well and was well attempted. With approximately 80% scoring at least one mark and almost 30% scoring three, this question provided suitable challenge. Many scored credit for identifying heating and weighing to a constant mass, but fewer referred to pre-weighing the sample. While there was some confusion on the difference between dry and burnt mass, many recognised the use of a Bunsen burner / temperatures up to 500 ^{o}C to get a burnt soil mass. Fewer mentioned the heating to remove water (at 80 to 100 ^{o}C) to get the dry mass. Many students scored well by systematically going through the stages of the process.

09.3

The best answered maths question on the paper, with more than half of students calculating the percentage change. Some were limited by the incorrect use of data from Table 6 (i.e. wet soil mass) but they still gained credit with error carried forward.

09.4

Although more than 40% of students scored one mark for identifying a relevant technique to analyse the data only around 10% could explain why. There was a lack of understanding of what the different techniques are used for and this is something centres could focus on. Some students attempted to describe the standard deviation graphs and overlapping with mixed success.

Question 10

10.1

This question discriminated well but was equally well attempted; approximately 85% of students scoring one mark or more, half scoring three or more and around 20% scoring five. The biggest confusion was students referring to water treatment stages rather than sewage treatment. Even in this case, many picked up credit on pre-treatment methods referring to screens to remove larger items. Secondary and tertiary treatment was less well understood, but some of the higher scoring students made excellent references to aeration tanks used to decompose organic material (secondary treatment) or the use of iron sulfate to remove phosphates, or UV light to kill pathogens (tertiary treatment). In some cases, the lower scoring students gained the mark for UV light as this is a cross over process used also in water treatment.

10.2

A very well attempted answer with a good spread of marks achieved. The biggest challenge for some students was the inability to focus on nutrient pollutants, with some referring to pesticides or heavy metal pollution. There was some good understanding of the processes leading to eutrophication and the impacts of this on the environment.
Level 1 students often lacked focus or included a large amount of irrelevant material. They may have understood the link between inorganic pollution and eutrophication but did not give specific references to process or outcomes.
Level 2 students showed good understanding of process and/or outcomes. However, they often did not have the same depth in understanding of both inorganic and organic or just focused on the processes leading to eutrophication without commenting on other environmental impacts.
Level 3 students commented on the subtle differences between the two pollution types, for example the deoxygenation process, or how the decay of organic nutrients could lead to the release of inorganic nutrients. These students tended to have detailed process understanding and commented on a range of environmental impacts eg organic pollutants releasing pathogens leading to dysentery, or ingested soluble nitrates leading to blue baby syndrome or human carcinogens.
Overall there was clear evidence of learning and application in some of the responses, though around 3% of students did not attempt this high tariff question.

Question 11

11.1

This question was the more popular of the two essay questions, though only just. The level of performance on this question showed good discrimination among the students, with around 60% of students achieving a Level 3 mark or above, and a quarter of students achieving a Level 4 or 5 mark.
This question was most commonly answered through reference to management of aquifers, reservoirs, seawater and water conservation methods. There was a greater tendency by students to describe the method and link this to how it could reduce environmental impact. A common trait of high Level 1 or Level 2 answers was spending too much time on the environmental impacts associated with water use rather than focusing on how these methods could reduce environmental impacts. A lack of range in methods, or depth in a small range of methods, also limited answers to lower levels. Level 3 answers tended to have greater focus on reducing environmental impacts but either gave varying depth on how the management method achieved reduced environmental impact or had detailed references to a couple of methods. Students achieving Level 4 often had both range and depth and a clear focus on how these methods reduced environmental impacts. Many students spent little time on the demands of society element to the question. Consequently, those students with a range and depth of methods and with a link to the demands on society eg our rate of water use, reasons for increased demand in some places, achieved Level 5. Some very good responses created clear discussion to determine spatial differences in use of different methods to suggest why some may be more successful than others in meeting societal needs and or reducing environmental impact. Some higher scoring answers included examples of use, for example named agricultural techniques, or references to environmental disasters eg Aral Sea which further enhanced their score.

Timing was still an issue for many students, who might wish to prioritise the essay earlier in the exam to maximise the potential mark scoring on this high tariff response.

11.2

On 11.2, around 65% of students scored Level 3 marks or above while more than 30% - scored Level 4 or 5 marks. Similar issues, relevant to 11.1, were evident here. Some lower scoring students focused less on the resource but on other elements of energy production or, more commonly, focused only on the environmental problems associated with mineral exploration. This was common among high Level 1 and Level 2 responses (although partial answers due to time pressure was another reason).

Among the most commonly included answers, were references to technologies to improve the discovery of deposits, controlling the issues associated with mine operation (eg noise, leachate, spoil), the use of low-grade deposits (through phytomining or bioleaching) and the concept of recycling / cradle to cradle design. Some higher scoring students made reference to exploiting new resources, eg polymetallic nodules on the sea bed, or processes associated with mineral resources for energy eg directional drilling or gasification.

As with 11.1, Level 3 students had a good grasp of the methods but in varying depth and range but may have been limited by their application to reducing environmental impact. Level 4 students more readily applied their range of methods to reducing environmental impact.

Level 5 students often had much greater focus on how these methods meet the demands of society, with reference to a future changing energy mix, the use of mineral resources for smart technology, or responses to environmental change.

As with 11.1, the issue of timing was evident and more consideration of this is required to ensure the examination is completed in full.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.