Questions matter

GCSE
Physics
8463/2H

Report on the examination

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General comments

Students demonstrated strong maths skills in this higher tier paper, with many gaining a high proportion of the available marks, even for the more complex calculations. There has been a notable increase in the number of students who are segmenting large numbers into blocks of three. For example, 321 000 000. This has the advantage of making it less likely they will transcribe the wrong number of zeros and makes it clearer for examiners marking their work.

There are a significant number of students that think a value with a square or cube in the unit needs to be squared / cubed when substituted into an equation. For example, acceleration is measured in m/s^2, so these students think that the numerical value of acceleration needs to be squared.

Students need to be aware that rounding a value in the middle of a calculation is often not helpful, particularly when they do it incorrectly. The use of equation triangles seems to confuse many students. Many could correctly write down the equation in one question but then tried to use an equation triangle but incorrectly. This results in no marks for the calculation. It would be much better if these students substituted into the equation as given on the equations sheet.

Unfortunately, there seems to have been an increase in the use of pens that do not scan well and writing that is illegible, sometimes because it is so small. Many students waste time by repeating the information given in the question, instead of using it as a starting point. There are times when a word or phrase is sufficient to answer a question, but some students feel the need to write a sentence.

Students had access to the equation sheets for this examination series.

1.1

Almost all responses gained marks, with the majority being awarded 2 or 3 marks.
The most common differences were for a comparison of speed, transverse and longitudinal, and whether each type of wave could travel through a vacuum.
Students struggled giving a completely correct definition of transverse and longitudinal, but this wasn't needed if they had already stated whether each was transverse or longitudinal. Some did get these the wrong way round, but they knew the terms.
A few quoted the speeds of each type of wave correctly. Again, this wasn't required if they had given the correct comparison of speed.
Whilst a lot of students knew that light was an electromagnetic wave, very few knew that sound was mechanical. Stating that sound is not an electromagnetic wave or that light is was enough to be counted as a comparison.
Approximately 50 % of the students scored 3 marks or less because they did not identify any similarity and so gave a level 1 response, regardless of giving many differences.

The most common similarity given was that both transferred energy; however some students did include the extra similarities of both waves being reflected, refracted, transmitted and absorbed.

Simply stating that light can be seen and sound heard was insufficient.

A number of responses included other information about how each type of wave was detected and how each could be used medically, which was not the focus of the question.

1.2

Almost all of the students identified the correct equation linking distance, speed and time.

1.3

A straightforward substitution, rearrangement and evaluation to calculate the time was completed successfully by almost all of the students. A few examples of incorrect rearrangement resulted in an answer of 0.025. Many students adopted good practice and showed both the substitution and rearrangement stages.

2.1

Most of the students could identify the independent variable in the investigation.

2.2

Most students were able to identify potential hazards in the investigation. However it was not always appreciated that a weight falling, for example, only becomes a risk of harm when it is clearly linked to what the falling weight could do to cause harm. The subsequent safety precaution should then have been linked to something that might be expected to be achievable in a school science laboratory. The wearing of steel toe capped boots is a precaution not normally associated with school science laboratories.

2.3

There were many good responses relating to improving the arrangement of the apparatus. These included using a ruler with a better resolution. A large number of the students suggested making the ruler "straight", which was insufficient, given that rulers are straight. Those who expressed this as vertical, parallel to the spring or similar were awarded the mark. Clamping the ruler was often quoted in relation to making sure the zero-mark lined up with either the top or bottom of the spring. Some of the students did not appreciate that this question was asking about the arrangement of the apparatus, as shown in the diagram. These students wrote answers in terms of taking repeat measurements and calculating a mean.

2.4

Most of the students were able to express the idea that the spring must have some length even when there is no force. A few noted that the variable measured was length not extension and others discussed proportionality. A small proportion mistakenly discussed the whole graph and the upward curve rather than why the line does not pass through the origin.

2.5

Less than 30 % of the students gained both marks for identifying why the extension of the spring starts to increase at a greater rate. There were many quotations of Hooke's Law and discussions regarding the limit of proportionality. Answers referring to elastic limit were acceptable, but the terms were not always used correctly. It is essential that students learn correct terminology. Most were able to describe inelastic deformation with many writing that the spring would not return to its original size when unloaded. However, a few incorrectly referred to elastic deformation.

2.6

Almost all of the students correctly identified the equation linking extension, force and spring constant.

2.7

The vast majority of the students were able to answer this question correctly. A few wrote the division upside down leading to an incorrect final answer. Students should be reminded of the need to show working even if done on a calculator. Showing working also helps to determine the appropriate mark when numbers are difficult to read.

3.1

Just over half of the students were able to correctly calculate the uncertainty. Those who did not were able to find the mean or the range and gain one mark.

3.2

Just over 60 % of the students identified that there was a random error in this investigation. About 30 % thought there was a systematic error, which would not have accounted for the variation in the results.

3.3

Students were usually able to identify factors that might affect the measurements made but did not always answer in terms of the variation in the measurements made. It was not always appreciated that the variation in the measurement of time was caused by a variation in a factor, such as the release height. An answer simply stating ‘the height that the ball was dropped from’ was insufficient, without mentioning the variation in the drop height in repeats of the procedure.

3.4

Just over 80% of the students were able to take values from the graph, determine the gradient successfully and correctly calculate the acceleration of the ball. In a small number of instances, the reciprocal of the gradient was determined.

4.1

This question was answered well. The majority of the students correctly stated 'convex' as the type of lens. 'Converging' was occasionally used.

4.2

Almost three quarters of the students scored both marks for completing the ray diagram. However a significant number of the others tried adding objects, images or additional incorrect lines.

4.3

Approximately half of the students failed to convert the wavelength correctly. Some of the students struggled with the rearrangement, but there were also numerous examples of mathematical errors for example 3.0/0.6 = 0.5 or 3.0/6.0 = 5. There was also a notable lack of understanding regarding the use of standard form. Students also need to understand that answers given in standard form are perfectly acceptable.

4.4

Only just over half of the students knew that when radiation is red-shifted there is an increase in wavelength. Incorrect answers such as 'frequency' and 'wave speed' were commonly seen.

4.5

Over 93 % of students knew why radiation from distant galaxies is red-shifted.

4.6

This question tested awareness of what red-shift tells us. Just fewer than 60% of the students gained this mark. Many of the students knew how red-shift related to speed but not the relationship between greatest red-shift and greatest distance away.

4.7

The James Webb Telescope orbits the Sun and those students who read the question carefully answered in terms of the Sun, but sometimes focussed on the different speeds at different points of an elliptical orbit. The majority of the students did not understand the Physics of circular orbits but were able to state that to stay in a circle the direction had to be constantly changing.

5.1

Students answered this free-body diagram question well with just over 60 % gaining both marks. Some students failed to realise that the air resistance should be represented by a smaller arrow than the one given in the diagram. Some students had drawn the dot again with labels added to their dot. Other arrows were occasionally added stating 'gravity' alongside weight.

5.2

Just over 60% of the students completed this calculation correctly. Most students understood the need to convert minutes into seconds. However, some students took data from elsewhere in the question, instead of using that given in the stem of this question part.

5.3

Students answered this question well. They generally had a good understanding of how the skydiver reached terminal velocity and described that air resistance increased to become equal to the weight of the skydiver. A lot of the students were also correctly stating that the resultant force was zero.

5.4

There were two ways to explain why the atmospheric pressure changed as the sky diver fell. In both methods many students were awarded only one mark, often by giving both versions of the 1st mark point.
Method 1: Some students described more air above not referring to more weight of air.
The second mark point was often missed as many students just stated so pressure increases, without referring to P=F/A.
Method 2: Many students correctly described that the density of the air increases, but the second mark point was often missed as students did not describe more 'frequent' collisions with the skydiver.

5.5

Only a small proportion of the students were able to draw a completely correct vector diagram and find the magnitude and direction of the resultant force. Most students were able to draw a triangle/parallelogram with the correct shape and orientation. The resultant force arrow head was often missing and when drawn was sometimes difficult to see. The magnitude was often correctly measured from the diagram or calculated. However, a significant number of the students measured the wrong angle.

6.1

This question was well answered with a number of students explaining their answer by linking it to F=ma showing a clear understanding of the link between variables. Students sometimes expanded their answers unnecessarily adding a detailed explanation as to why car X would have a lower maximum acceleration. Converse argument of car Y would have a greater maximum acceleration were common for this question.

6.2

This question topic proved difficult, as it has in previous exam series with only 15 % of the students scoring all 3 marks. Many answers did not show a scientific understanding of the concept, merely referring to the cushioning effect of airbags. Very few students scored the 2nd mark point being unaware of how the rate of change of momentum changed or deceleration. There were also a significant number of incorrect references to 'slowing down time'.

6.3

Just over 40 % of the students gained full marks for this multi-step calculation. Those who did mostly chose to use the equations of motion method before substituting their value of acceleration into F=ma. Very few students approached the problem from the kinetic energy method. The method using the average velocity was commonly used. However, very few students realised the necessity to use average velocity in their solution and were as a result a factor of two out in their final answer. This method also highlights that many students do not know which equations relate to constant velocity, and which relate to changing velocity.

6.4

Only a tiny minority of the students gained the 1st mark point for explaining why braking causes an increase in the temperature of the brakes, the majority failing to grasp the link between work done and frictional force. Many incorrectly referred to friction between the wheels and the road.

6.5

Just over half of the students gained marks for stating the risks of a large deceleration. Many students referenced crashes in their responses, notably involving the vehicle behind. Students rarely mentioned overheating, failing to make the link between this question and 6.4.

7.1

Just over 60% of the students were able to use Flemings Left Hand rule to work out which direction the copper rod would accelerate.

7.2

Just over half of the students scored all the marks on this multi-step calculation of acceleration. Those students not scoring full marks often failed to convert the mass correctly or did not rearrange the equation F=ma correctly.

7.3

This motor question was targeted at the most able students and proved very challenging. Only about one third of the students scored any marks at all. Only a very few of the students scored four marks. Most of the students who scored any marks were most likely to gain the 2nd and/or 3rd mark points. A significant number of the students confused motors with generators.

7.4

Another poorly answered high demand question. Many answers were to do with the coil being parallel to the field and there being no force. The majority of the students had missed that there would be no current flowing at that point due to the position of the coil. If this marking point was scored, responses usually continued to the idea of there being no forces acting. The 2nd mark point was dependent on the students scoring the 1st mark point.

8.1

Student responses for this question were poor. 'Outwards' was a very common and insufficient response to this question. Some students added arrows to the diagram to support their answer, but this was not seen regularly and was often done without care.

8.2

Overall, this question was well answered by about three quarters of the students. Many gave the correct answer to 3 significant figures. Some students did not write down their working or did not write down the value before they rounded it. Some students counted the zeros as significant figures or truncated their answer.

8.3

This question was aimed at the most able students and was challenging. This was reflected in the responses. Very few of the students scored all the available marks, but approximately 40 % scored at least one mark. Most were able to compare the densities of the two liquids. The biggest issue was that students tried to explain why the garlic was floating in terms of balanced forces, which didn’t answer the question.

9.1

Only about one quarter of the students scored the mark for explaining why a transformer core is made from iron. Many students had failed to include 'easily' with reference to iron being magnetised. Some students had incorrectly written about the conductivity of iron.

9.2

This was well done with nearly 80% of the students correctly calculating the potential difference across the primary coil. These students were able to manipulate the equation successfully and appreciated the correct order of magnitude for their answer. Common errors included not converting kV into V or failing to rearrange the equation correctly.

9.3

This question was poorly answered with students showing little understanding of the concept of induction. Just over 2 % of the students scored all 3 marks, with only about 30 % scoring at least 1 mark. Many of the students referred to a field around the primary coil, not appreciating that this field exists in the core. There were very few references to the cutting of field lines. Many students referenced potential difference being created rather than induced.

Mark Ranges and Award of Grades

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