



A-level  
**Physics**

7408/1 Paper 1

Report on the Examination

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## General comments

This paper was similar to those of previous years in terms of specification coverage and demand. Students had many opportunities to demonstrate their knowledge, skills and understanding across a range of topics. The usual variety of question styles including short answers, single and multi-step calculations, extended writing and multiple-choice were used. The questions were set in a range of both familiar and unfamiliar contexts.

The balance of assessment objectives and the mathematical demand were similar to those of previous series.

## Question 1

More than 75% of students were able to answer question 01.1 correctly. The most common error was to write 'electrostatic' for 'electromagnetic'.

Question 01.2 was similarly well answered. There were many variations seen for the electron antineutrino. Care needs to be taken when writing the symbol to ensure that the subscript 'e' is not the same size as the n.

In question 01.3, most students were able to identify the weak interaction as the one responsible for neutron decay. Many failed to obtain the second mark by giving weak or irrelevant answers. The best answers made a clear reference to leptons or the change in quark flavour.

The most common mark awarded in question 01.4 was for identifying the virtual photon as the exchange particle. Very few students went on to explain the change in paths in terms of conservation of momentum. This is clearly a part of the specification that is poorly understood. The question did discriminate quite well, however.

## Question 2

This was a particle-physics question set in the context of a pion–neutron interaction.

More than half of students obtained both marks for question 02.1. A common error was only putting one tick in each row. These students presumably did not realise that a particle could be both a hadron and a meson, for example. The command sentence makes it clear that multiple boxes should be ticked for each particle. Students should be encouraged to read these command sentences carefully so that they understand what they need to do.

Question 02.2 produced a good spread of marks and discriminated reasonably well. Most students identified conservation of strangeness as the rule being broken. Far fewer could explain their answer in sufficient clarity or detail. Many students referred to both weak and strong interactions in their answer, and therefore did not apply the conservation rule precisely to this situation.

Question 02.3 required students to look up data in the data and formulae booklet and most managed to do this. Problems arose with the rest mass of the photon. Many students identified the difference in rest mass between the pion and positron/electron pair and assumed it was 'given' to the photon. The best answers made it clear that the photon rest mass is zero and that the difference in rest masses would be seen in the kinetic energies of the products.

Surprisingly fewer than 35% of students identified annihilation of the positron with an electron as the source of more gamma photons in question 02.4.

Question 02.5 tests a very small part of the specification that appears to be often overlooked. As a similar question had been asked on a previous series, it was expected that this would answer quite well. Just under 50% of students were awarded the mark. The most common answer that was not rewarded was a vague comment about peer review.

### Question 3

This question on refraction and diffraction grating was set in the context of the analysis of light from stars.

The complex prism in Figure 1 is designed to separate out light into its different wavelengths whilst keeping the rays horizontal. The ray diagram in question 03.1 was drawn correctly by almost 50% of students. These spotted that the exit ray leaving normally means that the ray in B must be horizontal. Completing the diagram then simply requires joining the ray entering A to the one in B. Many untidy diagrams were seen, and students should be encouraged to use a ruler when drawing ray diagrams of this kind.

Question 03.2 was marked according to the student's answer to 03.1. This meant that both marks for this question could be given even if 03.1 was incorrect. Students who referred to angles, without stating the boundary they were referring to, were not awarded the mark for their reasoning.

Question 03.3 is another question that is on the specification that most students could not answer. There is a list of acceptable answers in the mark scheme that schools could refer to when teaching this. Answers that referred to the use of diffraction gratings in teaching were not rewarded.

The calculation in 03.4 was completed successfully by most students. The structure of the mark scheme allowed the award of intermediate marks provided it was clear what the student was doing. Students should be encouraged to set out their work carefully so that examiners can identify the steps and award marks appropriately. A common error was to provide the slit separation, rather than the number of lines per metre, and therefore not get the last mark.

Question 03.5 was one of the hardest on the paper. Many students made no attempt at analysis and made assumptions that led to zero marks. The best answers identified that the angles in the two situations would be the same. Students who did not do this often discussed percentage error in the angle being measured as the difference between them. It was also clear that many students did not understand the difference between accuracy and precision.

### Question 4

This question tested the students' knowledge and understanding of momentum and kinetic energy in the context of a particle interaction.

In question 04.1 many students attempted to work out a difference in rest masses between the particles, without success. Several other students identified the difference in masses of the products and used this to explain the 80% without any reference to conservation of momentum or to kinetic energy.

Almost 50% of students obtained both marks for question 04.2. The most common error was for students to use the combined energy as the energy of the neutron.

### Question 5

This question tested statics and mechanics in the context of a cable transfer.

In question 05.1 students were given a scale diagram of the two tension forces. It was expected that students would add the weight to complete the diagram and therefore work out the scale and hence the two tensions. This was rarely done. Many students attempted to measure the angles. This gained partial success, depending on the accuracy of the student's measurement. The first marking point was only given to students who successfully completed the diagram, however.

The mark scheme to question 05.2 was written in a way to give partial credit to students who could not complete the whole answer. This meant that it produced a good spread of marks and discriminated well. Many students attempted to use the constant-acceleration (kinematic) equations without modification and gained very little credit. Some students took the information in the question and drew a new equivalent diagram to arrive at the correct answer. This was only given credit when it was clear that this was what the student was doing.

Question 05.3 has been asked several times before in other contexts, but surprisingly few students could give complete answers. Too many answers were based on vague references to soft materials and absorbing impact. The best answers made it clear which physical principle was being used and applied it fully. The step in these answers that was missed by some was to state what was being kept constant. Many students suggested that the impulse changed for example.

### Question 6

This electricity question was set in the context of a thermistor circuit.

The calculation in question 06.1 was completed successfully by nearly 90% of students.

The multi-step calculation in question 06.2 produced a good range of marks and discriminated well. A surprisingly large number of students struggled to convert 22°C into kelvin. Many students used their answer to 06.1 as the resistance, despite the situation having changed. Many students had difficulty dealing with taking natural logs, believing that  $\log(A \div B) = \log A \div \log B$  for example. The unit also proved to be challenging for many students. Those who understood that the arguments of a function such as  $e^x$  are dimensionless spotted that B must have the same units as temperature.

The problems of resistive heating in thermistors was tested in 06.3. Many students understood that the current would cause heating of the thermistor, but few could go on to explain the effect that this has on resistance. The best answers referred to issues of thermal runaway, although this was not required for full marks.

A similar question to 06.4 was set on a recent paper. Despite this, few students were able to make the link between charge and energy, and current and pd. Students also had difficulty describing what they would do with the ammeters and voltmeters in their circuits.

## Question 7

This question tested the knowledge and understanding of stationary waves based on a displacement–time graph.

Most students who did not get the mark for question 07.1 assumed that the amplitude of the stationary wave and progressive waves were the same.

The calculation in question 07.2 was answered correctly by over 75% of students. Answers using a distance divided by time approach, rather than the wave equation, were not credited.

Students were split almost 50:50 between those who thought the phase difference in question 07.3 was zero and those who thought it was  $\pi$  rad.

Many students found question 07.4 quite difficult. There were three clear marking points which meant the question produced a spread of marks and discriminated quite well. A major issue for many students was the poor quality of the sine wave. Most students understood that the period was 1.6 ms but far fewer recognised that the amplitude was 4 mm.

## Section B

The multiple-choice questions tested many of the topics not covered in **Section A**.

There were five very accessible questions that were correctly answered by more than 70% of students. These were B12, B18, B14, B27 and B29.

There were two very demanding questions answered correctly by fewer than 12% of students. These were B10 and B25.

In B10 most students chose option B. This suggests that they did not realise that, when the energy transfer rate stays the same, using light of higher frequency means fewer photons per second and therefore a lower current.

In B25 most students chose option B. In fact, the correct answer was the least popular option. Careful analysis, using a sketch graph for example, would show that the answer is C.

There were several other questions where the most popular answer was incorrect.

In B15 most students chose C, which is the distance between two nodes, or half the wavelength.

In B20 most students chose B, presumably because they did not take into account the increased time of flight.

In B22 most students chose D, despite a terminal speed being mentioned in the stem of the question.

## **Mark Ranges and Award of Grades**

Grade boundaries and cumulative percentage grades are available on the [Results Statistics](#) page of the AQA Website.