# AS LEVEL
# PHYSICS

7407/1
Report on the Examination

7407
June 2022

Version: 1.0

## General Comments

The performance in this year's paper was of a lower standard than in 2019, with the mean mark falling from 37.6 out of 70 to 27.7 out of 70.

The paper was of an appropriate length with no significant increase in the number of non-attempts in the later questions. However, there were several parts of questions throughout the paper where more than 10% of students failed to attempt the question.

There were opportunities for students from across the ability range to demonstrate their knowledge and understanding of physics. Students often found qualitative questions more challenging than the quantitative questions. This was due to students providing superficial comments that did not provide sufficient explanation of the underlying physics. Students should be encouraged to support explanations with appropriate physics principles.

Able students typically performed well with calculations; their work had fluency and was well presented, showing a good understanding of how to apply their knowledge to the context. Other students were less likely to negotiate structured calculations successfully, with poorly structured workings that often contained errors and omissions.

## Question 1

01.1 This question required students to recall the baryon number and strangeness of a pion and a proton and then to apply the conservation laws to determine the properties of two other particles. Over 60% of students scored both marks. Some students were unable to apply conservation of charge correctly or mistakenly gave the pion and proton a strangeness.

01.2 This was done successfully with over 70% of students able to identify the sigma-plus as the particle with the quark structure $\mathrm{uus}$.

01.3 This question proved challenging for most students. Less than 35% of students gained more than one mark. The most able students were able to identify Y as a positive kaon and provide a well-written account of why the $\pi^+$ had a greater charge-to-mass ratio. Other students typically made statements without attempting any supporting explanation. Some students knew that Y and $\pi^+$ were both mesons but went on to state that they had the same mass.

Students should be aware of the command words in the question, the number of marks, and the size of the answer space as a guide to how much detail is required.

## Question 2

02.1 Just under 50% of students achieved no marks in this question. Good answers described the beam electron colliding with the orbital electron and the resulting energy transfer. They also described how the gas particle developed a charge of $+1\mathrm{e}$. Others were less successful through making statements that were too vague and did not address the context or the answers lacked the appropriate level of technical language expected of an AS student. A very common misconception seen was that a bromine atom captured the beam electron giving it a charge of +1.

02.2 Approximately one-third of the students gained both marks here. Many students had little or no understanding of the question and these answers typically involved subtracting 35 from 162. These students were unable to appreciate that the term *isotope* applied to the nucleus of a bromine atom and instead treated it as a term describing the diatomic molecule.

02.3 This question had a very low success rate with over 20% of students unable to make any attempt. Another 50% were unable to score any marks. The best answers appreciated that there were two isotopes, Br-79 and Br-81, and provided a good description of why the data supported them being present in equal quantities. This level of explanation was a good indicator of A-grade performance.

Other students were able to demonstrate some understanding by identifying the two isotopes and stating that they existed in equal proportions. These students were less successful in describing how the data supported their deduction.

Poor answers assumed that isotopes are the most common type of nucleon number and described this as being Br-80 due to 160 being the number of nucleons in the most commonly occurring molecule.

**Question 3**

03.1 Almost 50% of students scored both marks. The best answers showed convincing working leading to a correct answer. Common errors included dividing the frequency by the pulse duration and incorrect conversion of 6.0 ns.

03.2 Just over 10% of students scored both marks. The most common error seen was an answer of 3210 m where students did not realise that this had to be divided by 2. Some could not access any marks as they failed to appreciate that the speed of the infrared radiation was the speed of light which was given on the Data and Formulae sheet.

03.3 Just under 60% of students gained at least one mark in this calculation. The most common mistake seen was a use of $38\,^{\circ}$ as the angle of incidence.

03.4 This was a good example of a multi-step calculation that was an indicator of higher level performance with just over 40% of students gaining both marks. The most common error was the use of $c=f\lambda$ without any attempt to determine the speed of the infrared in the ice.

**Question 4**

04.1 This question was well answered with almost a quarter of students gaining at least five marks. These students typically produced coherent answers that addressed each of the bullet points in sufficient detail. Such answers used appropriate technical language to demonstrate a good understanding of the photoelectric effect.

Common errors included a limited use of appropriate technical language such as confusing threshold frequency with work function, and describing electrons as being ionised instead of released from the surface. Other students showed very limited knowledge and could only tentatively suggest that electrons were emitted when the electromagnetic radiation was incident on the metal.

04.2 Most students performed well in this calculation with over 60% gaining both marks. The mismatch of units in the photoelectric equation was a common error with students substituting the photon energy in joules and the kinetic energy in electron volts. Other students failed to gain marks due to forgetting to convert their answer in joules back into electron volts.

**Question 5**

05.1 Most students were unable to score any marks in this question. They had not read the question with enough care to appreciate that **R** was a point on a bright ring and, as such, was a position where the electron was demonstrating particle behaviour. Those who did identify **Q** as the position where the electrons were demonstrating wave-like behaviour could not provide any convincing explanation of why this was the case.

05.2 Students were more successful in this question with over 20% of them gaining at least two marks. These students were able to state that the wavelength had decreased and quoted the de Broglie equation to support this. Very few were able to relate this change of wavelength to the spacing in the graphite and to explain why there was less diffraction.

Some students attempted to use the wave equation to describe why the wavelength decreased whilst others stated that, because the electrons were travelling faster, they had less time to spread out.

**Question 6**

06.1 Over 25% of the students obtained all three marks. Many of these students had labelled **Figure 5** with distances and forces and gave clear working that was easy to follow. A common incorrect answer was $1.2\ \mathrm{m}$. This was usually caused by incorrect use of $d$ in the moments equation.

06.2 Most students gained at least one mark in this calculation. The reasons seen for failing to gain the second mark included: use of $3.6\ \mathrm{m}$ for $L$, thinking that the extension was the answer, and an inaccurate read-off from **Figure 6**. These errors reflect a lack of exam technique; students did not cope well in situations where key information was provided in the opening stem of the question.

Students should be encouraged to use a ruler to draw straight lines on diagrams to ensure an appropriate degree of accuracy in reading data from graphs.

06.3 Over 70% of students gained this mark. This calculation was much simpler than the previous question with both pieces of data provided close to the question. The best answers seen typically followed the steps of writing the equation, substituting the data, re-arranging to make the stress the subject, and placing the answer to an appropriate number of significant figures on the answer line.

06.4 Most students gained at least one mark by drawing an appropriate line with a negative gradient. Just over 20% gained two marks; these students appreciated that that extension had doubled and were able to determine the new extension for $d = 0$ but then incorrectly drew a line parallel to the original line.

## Question 7

07.1 and 07.2 Almost 40% of students scored one mark in 07.1 and 36% scored two marks in 07.2. A significant number of students who could not do 07.1 were able to do the calculation in 07.2. This suggests that these students knew the process involved in determining the component of the weight parallel to the slope but were unaware of the technical term used to describe it. Many students were able to use $P=Fv$ in question 07.2 to determine the force but were unable to relate this force to the component of the weight parallel to the slope.

07.3. Less than 10% of the cohort obtained two or more marks. Students did not seem to have any real-world appreciation of this 'zig-zag' path being easier than the direct path in **Figure 8**. They thought that the cyclist had travelled further, had encountered more resistive forces, and had done more work with a greater power output. These students offered efficiency-type arguments to explain why they thought that the useful power output had changed. Many of those who did appreciate that the effective angle had been diminished thought that the power output had increased by omitting the idea that the cyclist maintained the same steady speed.

07.4 Students had more success here with 32.7% of them able to score all three marks. However, over 45% of the students were unable to score any marks. Many of these students attempted to use $v = u + at$ thus not appreciating that motion was non-uniform or that this equation can only be applied to situations where the acceleration is constant.

07.5 This question proved too challenging for this cohort of students. Less than 5% of the students were able to obtain more than three marks. The answers seen were typical of work at GCSE level. The marks scored were limited to statements that air resistance increased with speed or that the gravitational potential energy was being converted into kinetic energy. Many students disregarded the instruction to outline the energy transfers and instead answered in terms of resultant forces and accelerations. The type of analysis that one would expect from more able AS students was rarely seen. A significant number of students stated that the cyclist was losing kinetic energy even though the velocity did not decrease.

## Question 8

08.1 Just over 20% of students were able to obtain both marks by being able to extract pertinent information from the question. Many students assumed that the $12\ \text{V}$ was across the $25\ \Omega$ resistor; on this occasion these students obtained one mark for use of $V = IR$ .

08.2 Considerably more success was seen here, with almost 80% of students obtaining both marks. There was less information to process, and students displayed a good understanding of how the resistance is determined in such a situation.

08.3 Poor performance in this question was largely due to limited use of appropriate technical language. Answers lacked a clear communication of the physics of why resistance varies in the filament lamp. The language used was often too vague and imprecise to be considered creditworthy at AS level. Most students could not describe the increase in resistance as being due to increased vibration of the lattice ions causing an increase in the rate of collisions between the delocalised electrons and the lattice ions. A significant number of students stated that this increase in resistance caused the current to decrease.

08.4 and 08.5 32% of students were able to score both marks in 08.4 while 45.7% were able to obtain both marks in 08.5 (albeit for reasons related to errors carried forward).
Many students failed to appreciate that the lamp and resistor were in parallel and simply determined the current in the lamp and quoted the total resistance as the lamp's resistance.
In 08.5, many students determined the power output across the lamp rather than the total power output of the battery.

08.6 Very few students showed any understanding of the difference between the two circuits and how this affected the voltage range and the efficiency. Just over 2% of students scored 2 or more marks. There was a significant number of non-attempts with almost 20% of students not providing any answer.

## Mark Ranges and Award of Grades

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