AQA

AS LEVEL
PHYSICS

7407/1 Paper 1
Report on the Examination

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Introduction

The mean mark for this year's paper was 28.0 out of 70.
Students appeared to have sufficient time to complete the paper with no significant increase in the number of non-attempts in later questions. However, there were several part questions throughout the paper where more than 10% of students provided no answer.

There were opportunities for students from across the ability range to demonstrate their knowledge and understanding of physics.

This year's examination again demonstrated that students find questions that require a qualitative answer more challenging than questions that require quantitative answers. Student performance in qualitative questions was often limited through their use of superficial comments that do not provide sufficient explanation of the underlying physics. Students often lack the ability to use appropriate technical language to communicate their knowledge and understanding.

Better-performing students typically perform well in the calculations; their work is well presented and easy to follow. Typically, they can build a coherent answer that connects all relevant information and leads to a correct answer. Poorer performing students are less likely to negotiate structured calculations successfully, and will typically carry out only the first stage in a calculation and present this as their final answer.

Overall, poorer performing students could improve their performance by:

- learning key facts and definitions
- writing equations in their working that have been re-arranged to include the subject
- working accurately with the prefixes on numerical data
- ensuring that they read-off data with due regard to accuracy.

Question 1

This question proved the most accessible question in the paper for E grade students.
Most students were able to gain some marks in parts 01.1 and 01.2. However, successful attempts at parts 01.3 and 01.4 were less common and usually indicative of grade A performance.

01.1
67% of students scored two marks. A significant proportion of the students scoring one mark incorrectly gave kaons a baryon number of 1.

01.2
51% of students scored two marks. Power of ten errors were common, with a significant proportion of students either ignoring the prefix or dividing by 10^6 rather than multiplying by it. Many students divided by 1.6×10^{-19} rather than multiplying by this factor. Alternatively, they multiplied by the Planck constant.

01.3
Over 50% of students scored zero in this part.
Many students misinterpreted this question, thinking that it was equivalent to energy conservation in beta minus decay. These students stated that another particle is produced that carries away the missing energy even though the energy of the products had increased.

Others attempted to refer to conservation of charge, baryon number and strangeness as evidence that energy must also be conserved, without any reference to the rest energies of the particles. Better performing students typically produced statements that answered the question in a clear and concise manner.

01.4
21% of students scored more than two marks in this part.
Many students were able to state the quark structure of Λ^0 as uds without being able to provide any support. These students appeared to be familiar with the quark structure of the particle rather than deducing its structure by analysing the information provided in the question.
Most students were able to make some progress by demonstrating some appreciation of the underlying physics by applying baryon conservation to an equation or by identifying weak interaction as the decay mechanism.

01.5
Almost 80% of students scored both marks. Common errors included:

- substituting the wavelength into $E=hf$ instead of the frequency
- forgetting about c when substituting into $E= \frac{hc}{\lambda}$
- lack of awareness that the values of h and c could be found on the Data and formulae sheet.

01.6
72% of students correctly identified the electron and electron antineutrino as the particles produced in the decay of a negative pion. The most popular distractors selected were boxes 1 and 3. Fewer than 4% of students selected box 4.

Question 2

The students found this question extremely challenging. They appeared to be unable to apply their knowledge of phase, superposition and interference to this context.

02.1
Almost 60% of students scored at least one mark whereas just over 5% scored all three marks.
Grade E students typically stated that the waves were in antiphase but could not explain why this had occurred. Many students scoring zero attempted to describe antiphase but had used ‘out of phase’ instead of ‘completely out of phase’.
Many students were able to describe how the path difference led to the phase difference. They often confused path difference and phase difference by stating that the waves were ‘half a wavelength out of phase’.

02.2
Over 10% of students did not attempt this part. Fewer than 10% gained both marks.
Almost 50% of students obtained one mark for finding the difference between 0.9 and 0.4 and obtaining an answer of 0.5 to one significant figure. These students could have obtained both marks by attempting to read-off the values with more regard to accuracy.

02.3
Better performing students did well in this question with 33% obtaining three marks. Almost 60% of students were able to achieve at least one mark. Lower attaining students were able to determine the period or the fraction of the cycle but did not know how to make further progress.

Students should be aware that in “show that” questions the onus is on them to demonstrate their clear working towards the answer. Performance could be improved by ensuring that all equations used have an appropriate subject and that each stage in the calculation is shown with equals signs being used correctly.

02.4
This was a challenging multi-step calculation that was beyond most of the students.
Just over 30% of students scored any marks at all, with 6% of students scoring all four marks.
Many students attempted to apply Snell’s law of refraction for a boundary using 137° as the angle of incidence. Others did not appreciate that the wavelength had changed when the frequency had changed and continued to use 356 nm for the wavelength in the layer. These students were able to achieve some of the compensatory marks, however.

Question 3

40% of students scored at least three marks in this question.
Many students were unable to provide a satisfactory description of an unpolarised wave or indeed to explain what is meant by polarisation. These students typically described the process of collimation rather than polarisation. This mostly occurred due to their inability to describe what is meant by a transverse wave with, many confusing planes of oscillation with directions of travel.
Some other students demonstrated a little more knowledge of electromagnetic waves, describing the *E* and *B* components, but thought that polarisation was the removal of one of these components.
Others thought that the sunglasses acted as a filter which allowed unpolarised light to pass through unaffected while blocking incident polarised light.

Question 4

04.1
43% of students scored two marks with a further 20% gaining one mark. Many students tried to resolve 160 N rather than *T*; this made the calculation considerably more challenging, and these students typically scored zero marks. Many were unsure whether to use sine or cosine or failed to appreciate that *F* was shared between the two horizontal components of the tensions acting at P.

04.2
51% of students obtained two marks with a further 33% obtaining one mark.
Many students did not score the second mark because they:

- did not change the mass into kg
- converted the mass into weight.

Some students attempted to use an equation of motion due to their inability to assimilate the information provided in the question. This showed a limited development of exam technique through limited awareness of the purpose of the stimuli provided in the question.

04.3
This question proved inaccessible to most students with over 94% of students achieving zero.
Many attempted to use $W=Fs$ even though the force was not constant over the distance shown in **Figure 6**. Another significant proportion of students used $W=\frac{1}{2}F\Delta L$, again scoring zero due to the non-linear relationship between *F* and *s* shown in **Figure 6**.

04.4
Over 60% of students achieved at least one mark in this part.
Grade A students typically achieved all three marks with grade E students able to make some progress. One mark was usually obtained for a correct conversion of km h^{-1} to m s^{-1} but quite often this was the only credit-worthy work seen in the working.
Common errors seen included:

- incorrect re-arrangement of $E_k = \frac{1}{2} m v^2$
- forgetting to use 82% of the available energy as the kinetic energy.

Many students attempted to use $P=Fv$ because they thought that efficiency was a reference to power in this context.

Question 5

05.1
Students performed well in this part with 47% of students achieving all three marks.
Those who made more limited progress were unfamiliar with how to determine the volume of air displaced each second and instead used $2\pi rh$ or $\frac{4}{3}\pi r^3$.
Here again, realising that this is a "show that" question was crucial; students must ensure that their working clearly demonstrates *all* the steps they have made to produce the answer.
Some students presented a one significant figure answer and this limited them to a maximum of two marks.

05.2
This part of the question expected students to appreciate that the displacement of the gas produced an upwards force equal to the weight of the helicopter. This was beyond the knowledge and understanding of most.
Fewer than 16% of students scored three marks and certainly demonstrated A-grade performance.
Over 70% of students scored zero in this part. Many students thought that the mass of gas displaced per second was equal to the mass of the helicopter. Many attempted to use conservation of energy to obtain an answer by setting gravitational potential energy equal to kinetic energy. It was very common to see 0.4×3.72 as the only working presented.

05.3
This part of the question was more accessible with almost 60% of students obtaining at least one mark. However, many students demonstrated a limited appreciation of the context and divided the energy stored in the battery by 39 s to find a power. This was incorrect as it assumed that all of the energy stored in the battery was transferred in 39 s. Many poorer performing students were unable to convert kilowatt-hours into joules.

05.4
Almost 60% of students were able to score at least one mark. However, fewer than 10% of students were able to make further progress and not even 1% scored all three marks.
Most realised that the helicopter was now heavier and that more work was required to keep it in the air. However, they were unable to describe how the helicopter produces the extra lift required. Also, they were unable to connect the increased amount of work done to power and therefore were unable to explain why the flight time would not double. Students would often make statements without being able to support them with an explanation that demonstrated their knowledge and understanding of the underlying physics.

05.5
58% of students obtained both marks. Almost 8% did not even attempt this calculation.
Mistakes seen included dividing the acceleration by the change in velocity and using an inappropriate equation of motion.

05.6
11% of students did not attempt this calculation.
32% of students scored one mark, usually for determining the maximum height above the ground or the distance travelled upwards from the position shown in **Figure 9** to the maximum height. These students presented 0.65 m or 0.041 m as their answer without appreciating how this applied to this context.

05.7
The lack of quality of the students' technical language was often the reason for limited progress in this part. Many thought that constant acceleration was the same as constant velocity and developed arguments based on acquisition of a terminal velocity. Many others offered Newton's third law as a reason to support equilibrium and Newton's first law.

Question 6

06.1
Fewer than 20% of students obtained this mark for recalling the meaning of emf.
Students can improve their performance by ensuring that they learn definitions and explanations of technical terms with an appropriate level of accuracy. Although there are not many marks for direct recall, it is important for students to be able to build these definitions and explanations into their answers.

06.2
39% scored two marks while another 25% of students scored one mark.
The students who scored one mark calculated the charge that passes a point in 37 minutes and presented this as their answer. This is another example of students carrying out one of the steps in a multi-step calculation with no awareness of the context or what they have been asked to determine. 30% of students achieved zero, often due to multiplying the current, voltage and time together. This demonstrated a limited appreciation of the fundamentals of electricity.
Lack of knowledge of prefixes again was an issue; students need to be much more aware of the need to check prefixes and know how to convert these before they substitute into equations.

06.3
Most students who used a current other than 44 mA scored two marks through an appropriate read-off from **Figure 11** and use of $P=VI$. 34% obtained three marks and a further 23.6% obtained two marks. Some attempted to find the area under the graph.

06.4
Over 20% of students obtained all 4 marks. They demonstrated an excellent understanding of the context and communicated their working in a well-structured manner.
This is another example where students took the first step in a calculation and believed that they had arrived at the answer. Almost 40% of students achieved two marks by substituting into $\varepsilon = I(R+r)$ and presenting 271 Ω as their answer.
Students should expect multi-step calculations in AS physics exams. Where there are four marks available, this should be the usual expectation.

06.5
This part of the question was challenging for all but the most able of students. 80% of students achieved zero. Most students were unable to apply lost volts and terminal pd to this context. Many students demonstrated only a GCSE standard of physics by stating that the voltage across the LEDs was unaffected because the components were in parallel. Some stated that because the current had increased so too had the terminal pd, thereby demonstrating a limited appreciation of circuits. Students need to ensure that they can back up their statements with relevant equations and principles to achieve marks at this level.

Mark Ranges and Award of Grades

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