AS LEVEL
PHYSICS

7407/2
Report on the Examination

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General Comments

The paper gave opportunities for all students to demonstrate knowledge and understanding of physics. The style of question varied from simple recall as seen in questions 12 and 14 to the more demanding contextualised, synoptic questions in section B. Often, questions that required analysis and interpretation were too challenging for all but the most able students. In many cases, students' answers were limited to superficial statements that demonstrated little understanding of the underlying physics.

The following questions had a significant proportion of non-attempts: Section A 1.5, Section B 3.2, 3.3, 3.4, 3.5, 4.2, 4.3 and Section C 32. It was difficult to ascertain if this was solely due to time management and instead may have been due to students being unable to know where to begin. Students should be encouraged to try and match the question to specification content as a means to unlocking the problem and enabling them to make some progress.

It was quite surprising that a number of the non-attempted questions were calculations and a more considered appraisal of the information may have yielded more insight. Students need to develop a better appreciation of the question layout and understand the scaffolding provided. The stem of the question will contain information that is pertinent to the entire question and due cognisance of any information presented here must be taken. Students should be in the habit of summarising the data provided and identifying the quantity they are being asked to determine. Once this has been performed, an inspection of the formulae sheet leading to selection of an appropriate formula may quite often allow progress to be made.

Higher achieving students produced work that was easy to follow. Calculations were clearly laid-out and contained equations with subjects. Their workings were often presented in vertical columns with extended working being easy to follow. Their qualitative work was insightful and was characterised by applying their knowledge to the context and backing up any points made with principles, laws or formulae.

Section A

Students should be mindful of the need to quote their answers to an appropriate number of significant figures. Calculated quantities should be shown to the number of significant figures of the data with the least number of significant figures.

Question 1

01.1 Many students incorrectly assumed the air-track glider's velocity was zero at the first light gate. Other common mistakes seen included using the total travel time of 2.09 s rather than 1.19 s and assuming that the distance travelled was 10.0 cm. Nevertheless, nearly a quarter of students scored all three marks.

01.2 There were lots of undeveloped statements; students implied that a longer time equalled a greater distance. In many cases, the supporting arguments presented were flawed with many students stating that with the same acceleration a greater time would result in a larger distance. There was some good analysis of the data but such an approach was usually only taken by higher grade students. Only 12.8% of students gained both marks.

01.3 The lines of best fit seen were generally of good quality. Many students demonstrated best practice for determining the gradient. Large gradient triangles were drawn with the read-off co-ordinates and corresponding differences clearly seen. Mistakes that occurred most frequently included not taking the false origin into account and drawing a gradient triangle that was too small. Very nearly 90% of students scored at least one mark here.

01.4 Appropriate use of significant figures is particularly important in Section A. Calculated quantities should be shown to the number of significant figures of the data with the least number of significant figures. 53.4% of students gained this mark.

01.5 A significant number of students disregarded the instruction “without drawing another graph” and chose to describe how to test the relationship by drawing a graph. They did not appreciate the significance of the term “directly proportional” and could only apply it to descriptions of the graph one would expect for such a relationship. Students were unable to describe how such a relationship could be tested by non-graphical means. A common error presented was that a linear relationship was the same as a directly proportional one. This was evidenced by statements such as “constant gradient”, “straight line”, “as *a* increases, *n* increases”. Disappointingly, only 6.9% of students scored the mark.

Question 2

02.1 Many students were able to demonstrate how to reduce the effect of the systematic error but only 12% were able to gain both marks. The main reason for this was the lack of detail in the description of how to reduce the effect of random error. Students need to ensure they give sufficient detail that is relevant to context and not limit answers to superficial “repeat and average” statements.

02.2 Many students were unfamiliar with how to use vernier callipers to measure internal diameters and lined up the magnet with the lower jaws instead. 31% of students were successful here.

02.3 High ability students dealt confidently and competently with this calculation. Their working was well-laid out containing few errors and no mid-calculation rounding. Other students gained some credit for partial workings where their method demonstrated some stages in the process. Students would be advised to ensure their workings are well-laid out with appropriate subjects to their calculations as this makes their partially correct work more convincing and more likely to receive compensatory marks. Some students attempted to find the difference in the diameters and use this in the formula for area rather than determining the areas separately and then determining the difference in areas.

02.4 The students often made little headway in this question. The plans seen lacked details on how to vary the mass and how to record the value of h. Many students did not know how to process the data to obtain a straight-line graph for $F = \mathrm{k}\, h^{-3}$. Just over 40% of students managed to score at least two marks here.

Section B

Question 3

03.1 There were a number of stages to this “show that” question. Because of its level of demand the mark scheme was less stringent than usual about how “show that” calculations should be presented. However, students should be encouraged to ensure they have fully demonstrated how the answer is obtained. These pieces of advice should be considered:

- any equations used should be written with subjects seen at each stage of the calculation;
- mid-calculation rounding should be avoided;
- the answer should be quoted to more significant figures than the value they have been asked to find.

03.2 The main error seen, when using F = ma and equations of motion, was not taking into account speed changing when calculating the time to stop. Students who identified the questions as being set up for a “work done = change in kinetic energy” generally obtained all marks (27.3%).

03.3 Good students were able successfully to complete this calculation (23.1%) whereas lower performing students appeared to have little appreciation of the problem and were able to make only limited progress, by perhaps finding the number of ions or converting the energy into electron volts.

03.4 Students failed to gain marks here for a number of the following common reasons: dividing the current by the time, using $2 \times 1.6 \times 10^{-19}$ for each charge carrier rather than 1.6×10^{-19}, and misremembering the prefix nano- as 10^{-12}.

03.5 This question proved to be inaccessible to all but the very best students. Only 10.7% of students managed to score anything on this item. The number of factors they had to consider proved too challenging for most. Where students realised that ionisation occurred when the alpha source was close enough, they often got confused about the effect this had on the current in the circuit and the resistance and potential difference across the air gap. Many students thought that an increase in current could only occur when the potential difference across the air gap increased.

Question 4

04.1 There were many good examples of work in this part from higher achieving students. On the other hand, lower achieving students had difficulty in following the question structure with many trying to find 97% of the speed of light in a vacuum rather than 97% of the speed of light in glass **A**. Another common mistake seen was students who simply multiplied $n_a \times 1.03252$. This was another place in the paper where students failed to gain marks due to incorrect use of significant figures. Just over a third of students failed to gain any marks.

04.2 Lower achieving students characteristically limited their answers to restating the relationship between λ_R and strain as shown in the graph. They were unable to make the link between the motion of the lift and its effect on strain and λ_R. Where students attempted to explain this connection, they often thought that the tension in the cable increased as the lift accelerated downwards. Only 7.4% of students scored two or three marks.

04.3 Many students presented answers that addressed the strength of the cable and its ability to withstand larger stress rather than the ability of the sensor to detect small changes in the acceleration. Two-thirds of students who attempted the question failed to gain any marks here.

Section C

This year saw an improvement in how the students used the stimulus material. They made better use of the paper by using the space to help them structure their calculations. Also, many more followed the instructions in the paper on how to select their answer.

Question 5
The majority of students (63.3%) were able to identify the correct answer. The most common incorrect answer was A; here students correctly identified the isotope but had not given sufficient thought to P's nucleon number.

Question 6
This question had a good success rate with most students (61.4%) selecting the correct answer.

Question 7
Students demonstrated a good knowledge of particle physics with the majority (62.7%) able to identify particle Q and the quark structure of particle R.

Question 8
Here, again, most students (70.1%) selected the correct response. The most common wrong answer was D.

Question 9
Most students (67.8%) were able to relate this gradient to the hc.

Question 10
Most students (64.8%) were able to select the correct answer, with distractor A being the most common wrong answer. These students did not take into account that the visible photon has a smaller energy than the ultraviolet photon.

Question 11
Students were less confident with this question, with less than 38.8% selecting the correct answer. B and C were often selected as the answer, with students demonstrating limited ability to re-arrange the de Broglie equation in the required manner.

Question 12
This question had a very high success rate with 84.2% of students able to recall the physical properties exhibited in the photoelectric effect and electron diffraction.

Question 13
Most students were not able to deal with this uncertainty calculation (30.1% correct). The most common incorrect answer was distractor C; these students did not know how to deal with the square root and instead added the percentage uncertainties together.

Question 14
The majority of students (58.1%) were able to identify the correct ranking of the prefixes. The most common incorrect response was B showing these students were unable to recall the values for pico- and femto-.

Question 15
38.1% of students were able to obtain the correct answer. Both A and C were common wrong answers.

Question 16
Most students thought that the transit time would either be halved or doubled, selecting B or C in almost equal numbers. Only 24% of students identified A as the correct answer and in doing so realised the transit time was unaffected by doubling the width of the core.

Question 17
Most students selected distractor B as their answer, the logic used being $\frac{2}{3}$ of the length able to vibrate would result in $\frac{2}{3}$ of the frequency. 31.3% of students arrived at the correct answer.

Question 18
Most students selected A as their answer, this being *d* rather than the number of lines per mm as requested. Only 25.5% of students were able to select the correct answer.

Question 19
Just over 40% of students selected the correct answer, with distractor B being the most common incorrect response selected; this answer was obtained by multiplying 0.12 by 6 to find their wavelength rather than realising that a wavelength was separated by 2π rather than π.

Question 20
Almost 40% of students were able to select the correct answer. The most common wrong answer selected was B; here students used a simple 2:1 ratio approach for the distance based on the information provided about the tensions.

Question 21
The most popular answer here was the correct answer (41% of students); certainly higher achieving candidates seemed confident with this calculation.

Question 22
Students demonstrated a limited understanding of the difference between acceleration and velocity, with the most popular answer selected being distractor A. Students found it difficult to realise that objects are still accelerating even when their instantaneous velocity is zero. 26.9% of students arrived at the correct answer.

Question 23
42.7% of students selected the correct answer, showing a greater competency for manipulation of formulae when numerical data has been provided.

Question 24
The most common incorrect response seen was distractor A. These students mixed up the acceleration of free-fall conditions with the conditions experienced under terminal velocity. There was a success rate of 38.7% on this item.

Question 25
A considerable number of students had difficulty in resolving vectors, with many choosing distractor B as their answer. Students who selected the correct answer (42.6%) had quite often drawn a vector triangle around the wind's velocity and this helped them to identify the correct component.

Question 26
This question was demanding, with only 18.8% of students able to select the correct answer. The most frequently selected incorrect answer was distractor A. The two approaches used were to realise the significance of the area under the force-time graph or alternatively to realise the significance of the gradient of the momentum-time graph.

Question 27
Students found this question challenging; there was a success rate of just over 20%. The most common incorrect response seen was distractor C. Quite often this was selected without any evidence of supporting calculations.

Question 28
Students most frequently selected C as their answer. Unfortunately, students seemed unaware of the need for V to be a constant when inspecting $P=VI$ and assumed direct proportionality. As a result, only 28.8% gained this mark.

Question 29
Most students selected B as their answer by converting 1 kW to 1000 W and dividing by 1.6×10^{-19}. These students seemed unaware of the kWh as a unit of energy; this was evidenced by their disregard of the 1 hour in their calculation. Students would improve performance by checking the specification content including section 3.1 (Measurements and their errors). Just under a quarter of students were successful here.

Question 30
Despite this idea being tested last year, students still seem to be unaware of how to determine resistance at a point on a curved V-I graph. The resistance is the ratio of the voltage and current at that point and not the gradient of the tangent to the curve. Distractor B was the most common answer selected by students; 32.1% of them gained the mark.

Question 31
Electricity remains a topic that students find challenging. Just under 20% of students selected the correct answer. The most commonly selected incorrect answer was distractor B. Students seemed unaware of the fact that the potential difference across the lower part of the circuit would be unaffected by an increase in the resistance of the thermistor.

Question 32
This question proved more accessible to higher performing students, with 34.5% selecting the correct answer. Those students who selected D (most common incorrect response) added the emfs of the cells despite the fact that the cells were connected in parallel. Students would do well to revisit rules for combining cells in series and identical cells in parallel.

Question 33

This question tested students' knowledge of formulae, units and their ability to rearrange. Over 30% were able to identify the correct answer. There were a number of pitfalls along the way and many students did not manage to deal with the s^{-1} in Cs^{-1} (the unit for the ampère); in this case they selected distractor A.

Question 34

This question proved a challenge (28.3% correct); the most common incorrect answer selected was distractor C. These students reasoned that the pd must be divided between the voltmeter and the 20 Ω resistor in a 1:1 ratio despite the voltmeter having an infinite resistance. Similarly, they were unaware that the total resistance in the circuit was 20 Ω rather than 10 Ω.

Mark Ranges and Award of Grades

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