AQA
Questions matter

A-level
Physics

7408/3A Paper 3 Section A

Report on the Examination

7408
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General Comments

The students found these questions more accessible than those in 2023 and they were able to score in all parts. It was good to see stronger students accessing more of the upper end of the mark range and we saw some agile minds at work with novel approaches successfully tried in 01.4, 02.8, 03.3 and 03.4.

The mean mark and standard deviation were higher than in 2023 and the 2024 paper performed in a very similar fashion to that in 2019.

Changes were made to the paper to draw the attention of the students to when a required practical activity was being tested. In the 2024 paper, question 1 was based on RPA 5 and question 3 was based on RPA 10.

Question 1 involved a familiar method used to determine the resistivity of a wire.
While most could read the micrometre screw gauge correctly, few explained why it should be closed using the ratchet.
To calculate resistivity in 01.6 many used a resistance per unit length value in **Table 1** rather than their own result from 01.5. A few substituted the screw gauge reading from 01.2 into their resistivity calculation.
Students were told to supply an appropriate SI unit for resistivity. Unless we specify that we want fundamental SI base units (as we did in 03.3) we expect the usual (derived) SI unit, which in this case is $\Omega\ \mathrm{m}$.
In explaining how to construct a line of maximum gradient some stated they would draw a line from the bottom of the first error bar to the top of the last bar, overlooking the need to make sure the line passed through all the other error bars. Some stated that a line could be drawn through the top of each bar to find the maximum gradient and a similar approach used to obtain the minimum gradient using the bottom of each bar. The use of '*best fit*' and '*worst fit*' was accepted but we could not make sense of '*best worst fit*' which was sometimes seen.

Question 2 rewarded students with good mathematical skills. Most can manipulate expressions with logarithmic and exponential functions. They knew how to test for an inverse-square relationship but often used only two points on the E_{V} against x graph.
In 02.6 too many suggested generic ideas about control variables: suggesting the use of the same wires, etc, was not given credit.

Question 3 was about how the force on a wire varied with current and with flux density. Most students were clearly familiar with the digital-balance approach used in the question. In 03.1 they were asked to explain how to make a copper rod horizontal. We stated that the metre ruler should be involved in their method, but many used it as a vertical datum rather than as a measuring instrument. As is often the case in such questions, some of the unworkable suggestions seen suggest that some students have little experience of setting up apparatus. The 03.2 left-hand rule problem performed as when last tested in 2018. Only the better students correctly realised that when the balance reading decreased, the force on the rod must be downwards. Weaker students struggled with the physics of the situation, forgetting to identify the current direction or to refer to the left-hand rule. Although only 17% correctly deduced the base units for k in 03.3, others were able to make some progress although their attempts could be difficult to follow. The use of simultaneous equations in 03.4 was widespread even though many failed to read the M_2 intercept from the correct scale. In 03.5 many understood what the consequences of the misplaced rod would be for the graph, but others seemed to think that electromagnetic induction was involved. We were surprised that some thought the effects of the field between the magnets would not be felt when the rod was positioned just above the yoke.

Rounding during a multi-part calculation, as in 01.4, cost marks and some gave their final answer to more than 4 significant figures (sf) which we did not accept. Students should understand that in a 'show that' such as 02.2, we expect the final answer to be to one more sf than the sf quoted in the question. They must also remember that a final answer needs to be to the same sf as the least accurate data. In 02.4 many rounded at the answer line to 630 or 640 but these are still 3 sf numbers, as are all the contributing data in the calculation because only leading zeros are not significant.

More than in recent years, examiners are raising concerns about illegible work, including faint or very small handwriting. Some centres do not seem to recognise that this could compromise the assessment of their students' work. When students are clearly struggling to make themselves understood centres should consider providing a scribe or word processor.

Question 1

We expect students to have used a micrometer screw gauge and in 01.2 87% correctly indicated that the reading shown was $6.72\ \mathrm{mm}$.
In 01.3 they were told to state and explain how the micrometer should be closed; many could 'state' what they should do but then overlooked the 'explain' part.
In 01.4 the working could be hard to follow but usually saw one of several acceptable approaches, including some novel potential-divider solutions. Having been required to show that R was about $0.5\ \Omega$, a 2 sf final answer 0.51 would have been fine, otherwise only 0.512 and 0.5117 were accepted. Over 70% scored both marks.
Parts 01.5 and 01.6 proved very accessible. A clear majority correctly identified nichrome by matching up their 01.5 result with a value of resistance per metre from **Table 1**, deducing the wire diameter and completing the resistivity calculation successfully. Some imported a power of ten error from their 01.5 calculation which led to them identifying copper. Others simply ignored powers of ten altogether and just tried matching up numbers so a resistance per metre of 1.68 became 0.168 and led to alumel.
Part 01.7 was not well answered. We wanted students to compare the L bars and the R bars separately. A simple statement that the L bars were the same was accepted but we wanted a quantitative comparison of the R bars. Some ignored the L bars and others penalised themselves by not mentioning error bars at all. A few compared the bars at the first point with those at the fourth point (and not the fifth point as specified).
Most knew how to determine the uncertainty in a gradient but the use of error bars in drawing the lines of maximum or minimum gradient was poorly explained. Although we expected students to explain how to determine the absolute uncertainty, we allowed them to give correct expressions for fractional or percentage uncertainty.

Question 2

In 02.1 most wrote something sensible about the display, as the question said they should, although a few said that the selector switch in **Figure 6** was shown set to range C.
In 02.2 65% got both marks and only a few did not use logs to base 10 or substitute 2840 correctly. However, some solutions were overlong, extending beyond the usual answer space.

In 02.3 many said they would obtain E_V and x data from **Figure 7** and show that these gave similar values of $E_V \times x^2$. We wanted these data to be from more than two points but only a few thought to mention this detail. We didn't allow the use of '*multiple points*'. An alternative approach was to plot E_V against x^2 or plot $\log E_V$ against $\log x$ and this could get full credit as long as the expected outcome was explained for each graph.
The idea behind 02.3 was developed in 02.4 and many calculated a suitable value of x when $E_V = 130$ lx. Some penalised themselves by rounding their final answer to 630 or 640 mm.
In 02.5 most correctly supplied 1645 and 1.73 then used information from their completed **Table 3** to justify why range B should be used to determine R. Some tried the idea that resolution of range B was superior but were unsure whether they should say that the resolution was '*smaller*', '*greater*' (we accepted either) or '*better*' (we rejected this).
Students are well aware of what a control variable is, but they are not always able to identify suitable examples. In 02.6 they often made generic suggestions such as temperature or the length of the connecting wires, but we wanted things that, if changed, would have a more obvious impact such as background illumination, lamp brightness or slide thickness.
Most students can find the unknowns in decay problems. In 02.7 about half knew that μ would be found by calculating the negative reciprocal of the gradient of an $\ln E_V$ against N graph. A handful correctly explained how to obtain μ using a $\log E_V$ against N graph. In 02.8, once again about half correctly deduced that eight slides would be the minimum needed to reduce E_V by 50%. Some tried trial and improvement, but credit depended on showing that $N = 7$ did not work while $N = 8$ did. A common error was to use $E_V = 0.5$ which led to $N = 74.3$ but we allowed one mark if this was then rounded to 75.

Question 3

03.1 is a type of question that students with limited practical experience struggle with. Once again, we have to point out that clamp stand rods may not be used as a vertical datum, but benches can be assumed to be horizontal. The question said a metre ruler must be involved in establishing that the rod was horizontal. Some used the ruler to measure between bench and rod at different points and check that the heights were the same. When this idea was combined with an appropriate use of a set-square to make the ruler vertical, usually explained by annotation to **Figure 10**, all three marks were awarded. Others placed the set square where the vertical ruler met the rod. We did not allow this because a set square is too short to accurately judge whether the rod is horizontal.
Good sketches saved those who struggled to explain their methods, but poor sketches condemned others who showed gaps between their set squares and the bench.
Most knew what was behind 03.2 but only the better ones were able to identify the direction of the force on the rod. Some good answers went through the action-reaction idea in great detail to make sure the examiner knew what they were thinking. Others just referred to '*the force*' and assumed it was upwards because the balance reading had decreased when there was a current in the rod. We gave no credit for current '*from positive to negative*'. Those who did not mention a current direction could only get one mark. However, most could predict a suitable magnetic field direction having identified directions for their force and current although we wanted to see the left-hand rule mentioned in justification.
The solution to 03.3 was, first, to produce a homogeneous expression involving k, flux density, current and mass; second, to eliminate flux density using force, current and length, then to eliminate force using mass, length and time. We allowed working in which quantities and units were mixed, but many failed to connect the parts of their solutions using equals signs, making the work difficult to assess. 17% reached the correct solution of s^2 in a few lines and earned all three marks. Others slipped up at the last stage of re-arrangement to get s^{-2} which cost one mark. Some deduced a homogeneous expression with non-base units, usually $k = \text{kg T}^{-1} \text{A}^{-1}$ which got one mark. We also saw much '$\text{kg} = k\text{TA} + \text{kg} + \text{kg}$' which the

student then tried to simplify by cancelling kg as if performing conventional algebra. Over 60% made some progress and use of $F = BIL$ and $\mathrm{N} = \mathrm{kg\ m\ s^{-2}}$ were often seen.
The use of simultaneous equations to determine Y in 03.4 was widespread. Predictably, the use of the wrong scale to determine the M_2 intercept was also common. The M_1 and M_2 intercepts were usually recorded to 2 decimal places as we required and 16% gave completely correct solutions for three marks. Those reading off M_2 incorrectly as 135.35 could still get two marks. Some thought that reading off M_1 and M_2 intercepts at a particular non-zero current, usually 5.2 A, would allow them to find Y. The majority of these attempts failed because the student did not appreciate that B was different for each of the simultaneous equations so they could not cancel the kB terms. A very small number did recognise that problem and worked out both gradients to arrive at a completely correct value for Y.
As in 03.2, the writing in 03.5 often betrayed a poor understanding of how the physics of the current balance worked. Several referred to flux cutting or alluded to induction in other ways. However, the general trend was to spot that B would be smaller so the gradient would be less steep, and the intercept stayed the same. Some saw that the gradient was kB so a smaller B meant a smaller gradient while others saw that the intercept was $2Z + Y$ and hence independent of B. However, very few rarely put the whole thing together, so we saw lots of two-mark answers but very few with all three. We expected students to know that the field between the magnets was uniform, but it did not end abruptly at the top edges of the yoke, yet some said that B at the rod was undetectable. They concluded that the gradient would be zero and the intercept was unchanged. We allowed one mark for this idea.

Mark Ranges and Award of Grades

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