AQA

A-LEVEL
PHYSICS

7408/3A
Report on the Examination

7408/3A
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General Comments

The students' performances on the 2023 paper suggest that the effects of the disruption since 2019 have still not fully disappeared.

Two of the three 2023 questions were set in contexts from the list of twelve required practical activities. Poor presentation in written, numerical and in graphical work often made interpretation difficult and, in some instances, compromised the credit that could be given. The extended writing was less open-ended than in 2019.

Most students understood what the command words implied: when invited to "*State*" (eg 02.2 and 03.6), most gave abbreviated or even one-word responses. When asked to "*Suggest*" (01.2), "*Justify*" (03.3) or "*Discuss*" (02.3 and 03.1) they usually wrote in full sentences. It was rare to find answers that extended beyond the answer lines provided. The quality of writing was mixed; fluent writing was hard to find. In 03.1, only the strongest students used technical vocabulary confidently. Question 03.3 was designed to test understanding of ideas about uncertainties outlined in the Practical Handbook. Better-performing students showed they appreciated that two judgements were required when measuring with a protractor.

Questions 02.1 and 02.2 explored students' understanding about the use of data logging, as required in section 8.1 (ATk) of the Specification. Many clearly showed experience of having used this equipment.

Compared to 2019 the numerical work was more demanding and often required a multi-step approach. Most mathematical arguments were well laid out and easy to follow, the best example being in 01.3 where many identified one of the several possible solutions. Students could solve 01.5 and 01.6 in either order by reverse-working and creditworthy work was usually easy to discover.

Each question contained parts in which students were required to translate information between graphical, numerical, and algebraic forms (MS3.1). All of these parts discriminated well although many penalised themselves in 01.6 by failing to annotate **Figure 3**.
The stronger students scored marks across all parts of the paper, whether through continuous writing or numerical work. The weaker students mainly scored their marks in question 2.

Most marking points were accessible, the exceptions being in 01.4 and 02.6.
In 01.4, students often did not use **Figure 1**, a problem we did not anticipate. In 02.6 some could not make progress because they had not drawn a best-fit line in 02.5.
Virtually all could score marks in 02.4 and 02.5 although many penalised themselves by not drawing a curve. The urge to make every graph a straight line (and in some cases forcing it through the false origin) has been a criticism raised in previous reports, as has the incorrect use of symbols in answers. We expect any symbols to be those identified in the question; otherwise they must observe agreed conventions. Hence we did not accept G for g or accept the mis-labelling of an axis, eg $\mathrm{mT}/B_{\mathrm{H}}$.

Question 1

In this question, based on required practical activity 3, students were required to explain how g could be determined by a free-fall method using evidence from a strobe photograph.

There was no expectation that students should have direct experience of using a stroboscope but that does not preclude the use of photographic images, made with the aid of a stroboscope, to analyse the motion of a falling object. Mobile phones can produce videos of objects in free fall that perform a similar function. Many students showed through their working that they were well aware of the independent effect of motion in horizontal and vertical directions.

01.1
Over half of the students gave the correct response.

01.2
Students were asked why the duration of each flash should be short. Some stated that this increases the number of images produced, but we expected them to comment on the quality of each image or to explain that this allowed the position of the ball in each image to be determined.

01.3
Much of the work was easy to follow, even though some used the space on page 4 to show a re-arranged equation. There were many possible valid solutions, the most popular of which was to suggest that $\frac{n}{2f^2}$ was plotted on the x-axis so that g was the gradient. Students must make sure that they avoid ambiguous statements such as "we need to find the gradient to get g". They also had to make sure to explain clearly how g was obtained; a statement in which g was not the subject, such as "the gradient of the graph is $\frac{g}{2f^2}$", was not accepted.

01.4
We expected students to use **Figure 1** to identify N, the image number at the instant the ball hits the floor for the first time. We accepted $N = 17 \pm 1$ but many missed the intention of the question and tried to substitute $n = 0$ or 5 into $H - h = \frac{u_0 n}{f} + \frac{g}{2}\left(\frac{n}{f}\right)^2$. It should have been obvious that the $n = 0$ approach could not work. The $n = 5$ approach led to attempts to measure h directly from **Figure 2** and, in some instances, this worked, but many failed to recognise the broken dimension convention and wrongly concluded that h was $\frac{H}{2}$.

01.5
We expected them to determine the horizontal velocity by dividing the distance between two suitable images by the corresponding time; we accepted the use of their distance between the second and third contacts (usually $1000\ \text{mm}$) and their time from 01.6.

01.6
Comparatively few added suitable annotation to **Figure 3**. Rather than take the expected route of dividing the distance by their 01.5 result, some used $s = \frac{1}{2}at^2$ with $s = 495\ \text{mm}$ and $g = 9.79\ \text{m s}^{-2}$ but apart from those who forgot to multiply their t by 2 or who failed to cope with the mixed units, this approach worked well. Some credit was given for determining the time by estimating a non-integer number of intervals between the contacts.

Question 2

This question was about an investigation into the properties of a lamp. Ideas about data logging and the use of a variable resistor as a source of variable potential difference were explored.

02.1
There were many two significant figure (s.f.) answers, but the majority of these were 1.6 which got full credit. Some penalised themselves by trying to work out the rate using adjacent points.

02.2
The idea that data loggers reduce random error or improve accuracy was the most popular but each of the other three approaches in the marking scheme were represented. We did not give credit for claiming that precision or resolution was increased or that uncertainty was reduced. When asked to state two advantages, students must make sure that the second of these is not a variation on the first.

02.3
This part was well answered and many recognised that they should calculate the minimum current or the minimum potential difference when X was set to maximum resistance. Better-performing students often went on to compare these results with relevant data in **Figure 4** to justify their rejection of circuit 1. A few proved circuit 1 was unsuitable by comparing $2.3\ \Omega$ with the resistance calculated using the first or second points on **Figure 4**. We wanted them to say that the potential divider could vary the pd from 0 to 12 V so circuit 2 could produce the data in **Figure 4**, but this detail eluded most. Some tried to calculate the maximum current in X for circuit 1 but mistakenly used $2.3\ \Omega$ in their calculation.

02.4 and 02.5
Although most found 02.4 and 02.5 straightforward, some penalised themselves in 02.4 by inconsistent s.f. in the data or, in 02.5, by failing to recognise the non-linear trend in their plotted points. It was surprising to find how many did not draw any best-fit line.

02.6
We wanted students to extrapolate the graph to read off P_r at $V = 12$ V. Further credit could be earned for making another read-off at $V = 6$ V and using these values in a correct calculation. Some tried to calculate P_r using $\frac{12^2}{2.3}$ by assuming that the lamp resistance was always $2.3\ \Omega$.

Question 3

This question was about investigating the magnetic flux density along the axis of a circular coil and addressed ideas behind required practical activity 11.
There was no expectation that students should have seen a pair of Helmholz coils used to produce a uniform magnetic field.

03.1
Some stated the search coil was a suitable detector because it "cut flux", but the answer we expected was that it was not suitable because the flux through the coil was not changing, hence there would be no induced emf. A few took an alternative (and valid) approach by stating that the coil was suitable provided it was moved/rotated in order to change the flux through it. Reading the accounts of these students suggested they may have seen a demonstration of the Earth inductor

principle. There were some who confused flux with field while others seemed to see the search coil as a generator and quoted the induced emf formula from the data sheet.

03.2

Many recognised that $\cos 25$ was involved in the calculation but to get credit we needed to see this used in a valid percentage-difference calculation. About a third of the students gave fully correct solutions.

03.3

It was good to see that many understood that two judgements were involved in making a measurement with a protractor although some struggled to make this clear enough. Many stated that the uncertainty in a reading was half a degree, although several thought the protractor divisions were in millimetres. Several thought that the uncertainty in a reading was $0.1°$ and others tried to use the “half range over reading” idea more appropriate when calculating percentage uncertainty in tabulated data.

03.4 and 03.5

Both parts involved interpretation of **Figure 11**. In 03.4, x_0 proved slightly easier to identify than r. Common errors were $x_0 = 58$ and $r = 34$. In 03.5, few realised that they could get the required result by doubling the value of B_H where the graphs intersected.

03.6

We hoped to see the “field lines are parallel” and “equally-spaced” ideas but we found too many generalised or imprecise statements such as “from north to south”, “closer together where field is stronger” or “field lines are uniform”.

03.7

Although only about a third of the students could make progress, we saw some excellent answers that surpassed expectations. Some were able to score for drawing a continuous line with a negative gradient or for a line that passed through $B_H = 0$ at $x = \frac{r}{2}$. Only a few correctly identified that the value of B_H at $x = 0$ or $x = -r$ would be $\pm 0.43\ \text{mT}$.

Mark Ranges and Award of Grades

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