AQA

A-LEVEL
PHYSICS

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Report on the Examination

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General Comments

The paper performed in much the same way as in 2017 and 2018. This was a disappointment after the improvements in mean mark and standard deviation seen in 2019, the last full season of this paper. The demands of this paper were not significantly different from those in 2019.

Most parts of the 2022 paper provided opportunities for stronger students to demonstrate their ability while preserving the chances of others to show what they knew. Most marking points were accessible. Exceptions were 02.1, 04.1 and 04.3, as discussed later.

The questions were designed to allow students to demonstrate competence in the key techniques and investigative approaches required in three of the twelve assessed practical activities.
This cohort showed that when the question provided enough structure to deter them from improvising, they could produce coherent and sensible extended writing, as in 01.3 and 02.2.
Question 04.2 was a different story, with some students referring to ‘suction’ and equating pressure with ‘gravity’.

Calculations were usually easy to follow but in 01.2 and 04.6 relevant details were sometimes spread across the answer space with little connective reasoning.
Students found question 4 significantly harder than the rest of the paper; students of E-grade standard might only score marks in 04.4 and 04.7.

The main misconceptions seen were thinking that:
- experimental data will always perfectly confirm a theory; students must provide a reasoned judgement before they accept or reject such evidence, e.g. in 04.1;
- pressure can be equated with force, e.g. 04.2;
- a best-fit line must be a straight line, e.g. 04.3.

Gaps in specification knowledge:
- the use of a CRO as a clock (3.7.5.5);
- use of a mirror to avoid parallax error (7.1 ATc).

Things students could do better:
- spotting the intention of the question: in 04.5 we asked why the gradient confirmed Boyle’s Law but only about half of the students made use of the space provided for a calculation;
- check for false origins – many said the intercept in Figure 13 was 1.685;
- ‘add detail’ to a Figure to illustrate an answer when prompted to do so – many saved their answer in 02.1 by taking this advice;
- refer only to a variable using the symbol or description given in the question; e.g. in 02.2, y is defined as displacement so calling it “extension” or “length” leads to student confusion;
- be more concise and targeted with extended writing; consider using bullets or lists;
- review recent question papers and marking schemes.

Things teachers could do better:
By now we hope that teachers have understood our approach to the assessment of the required practical activities in this paper. We do not stick rigidly to the standard versions of certain experiments. From time to time students will see an arrangement they are familiar with (as in Figure 12); more often than not this will not be the case. We encourage teachers to enrich the experience of their students by varying their approach to practical activities.

Question 1

This question tested students' understanding of the use of a CRO as a clock.

In 01.1, nearly two-thirds correctly identified *Y*-shift.

For full credit in 01.2, examiners wanted to see use of $\text{speed} = \dfrac{2 \times \text{length of rod}}{\text{contact time}}$.
Some students missed the factor of 2 or assumed that the time-base setting referred to minor divisions. It was disappointing that more than half of the students could not score.

In 01.3 there was strong representation at each mark. Better students took note that they should add quantitative detail. Once it was clear that the new waveform would have twice the number of cycles and would therefore no longer be fully visible, most could correctly identify that the time-base should be adjusted. '*X*-gain' was accepted for time-base and many correctly suggested changing the setting to 0.1 ms div^{-1}.
Some wrote that, when a rod of twice the length was used, the period / wavelength / frequency / speed of the waves would change.

Question 2

This question was about finding the Young modulus of steel in the form of a thin strip and addressed ideas behind required practical activity 4.

The use of a mirror to avoid parallax error was also tested in November 2021 (question 03.2) when only 10% could answer successfully.
In 02.1 few could improve on 'view at eye level' or 'move the ruler closer to pin'. Annotation to Figure 6 enabled some to show how a set-square could be held against the ruler to provide a horizontal reference but it was rare to find answers that earned both marks.

In 02.2 most students outlined a plausible strategy (in which y was the dependent variable) and suggested a valid plot of their data. Although the majority opted to plot y against m, examiners did not insist that y was plotted on the vertical axis of the graph. Many went on to show how they would find the Young modulus using the gradient of their graph.
About 25% scored at least 4 of the 5 marks. These students explicitly stated that L was a control variable (providing m was being varied) and/or suggested suitable instruments with which to measure L or w or t. In some cases, where the term 'extension' was used (rather than 'displacement' or y), students had decided to stretch the strip lengthways. Using $w \times t$ for cross-sectional area and $\dfrac{y}{L}$ for strain they said E was the gradient of a stress/strain graph.

Question 3

This question was about finding the resistivity of conductive putty and addressed ideas behind required practical activity 5.

In 03.1, about two-thirds of students identified that use of callipers could deform the putty or cause the diameter reading to be reduced.

Although a 'show that' question, 03.2 was very similar to 03.3 in November 2021. More than half earned both marks by producing an answer that rounded to 2.37%.

Nearly 30% scored full credit in 03.3. Some penalised themselves by not combining the percentage uncertainties correctly, but could still get credit for determining a recognisable volume or for substituting their values into a calculation of the uncertainty in the volume.
There were isolated cases where maximum and minimum volumes were calculated based on the extreme values of d and L. This proved to be a viable alternative to the anticipated method and could earn full credit.

In 03.4 students were back on familiar territory and (mostly) drew an acceptable line, measured the gradient, and did the required calculation to find the resistivity. A common error was to miss the multiplier with the label on the L^2 axis leading to 10^{-5} on the answer line.
The margin of error with the numerical value was small so truncation to 2 sf was ill-advised.
Over half of the students scored at least 3 marks.

Question 4

This question was about methods to confirm Boyle's Law (required practical activity 8). The method described in parts 04.1 to 04.3 was for a loaded gas syringe. In parts 04.4 to 04.7 the method was the familiar version in which pressure is applied to air trapped above a column of oil.

04.1 is a similar question to 01.3 in November 2021. While half could perform calculations that could lead to a conclusion, nearly all then stated that their '$M \times y$ values were different.'
Random error will inevitably affect real data so students were required to make a reasoned comment about the extent of the discrepancy.
Some seemed to think they were being asked to test for an exponential relationship while others, sowing the seeds of the downfall in 04.3, said the points in Figure 10 lay on a straight line.

In 04.2 students needed to explain how the pressure inside the cylinder changed as P moved downwards, how this led to P coming to rest and why P fell out of the cylinder when the valve was opened. Misconceptions seen included saying that P came to rest when the internal and external pressures were the same. Some thought pressure could be equated with force or suggested that there was a 'suction' effect on P. Others said that, when the valve was opened, air rushed into the cylinder and pushed P downwards. Many struggled to make progress and 60% were unable to score.

The instruction in 04.3 to 'Draw a best fit line on Figure 10' seems to have persuaded many to draw a straight line. Only a quarter of students drew a smooth curve following the obvious trend of the points. Many realised they should extrapolate their line to deduce y for the inverted cylinder but nearly all read off at $M = -0.35$. Since M did not include the mass of P, the y read-off should have been made at $M = -0.70$.

Meniscus is a term for the curved surface of a liquid. In 04.4 many used the term appropriately in explaining the error made by the student. Others earned this mark with a sketch.
The alternative suggestion that the student thought the sub-divisions were at $0.1\ \text{cm}^3$ intervals was accepted. At least a quarter failed to record 35.8 as the correct reading.

In 04.5 students were asked to explain why the gradient in Figure 13 confirmed Boyle's Law. A calculation to show the gradient was approximately -1 and relevant algebra to explain the $y = mx + c$ form of Figure 13 were expected. Some did not use the blank space provided for a calculation and just said the line had a negative slope.

In 04.6 students were required to make use of a point on the line in Figure 13 in their solution. Gradient calculations were not accepted as part of the working here. Many decided to substitute their data into the equation for the line in Figure 13. This required a calculation of the intercept but many claimed the value to be 1.685. Others ignored the intercept altogether and stated that log V = the gradient × log 0.34.
It was possible to solve this problem in two or three lines but keeping more complex working error-free was often an insurmountable problem.

Students found 04.5 and 04.6 to be very challenging and only a third of them were able to make progress in either part.

In 04.7 keeping temperature constant was correctly identified by over 80%. About half of these added the second mark by saying they would change the pressure slowly, showing good recall of the required practical. Examiners did not allow 'carry out the experiment at room temperature'.

Mark Ranges and Award of Grades

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