A-LEVEL
PHYSICS

7408/1 Paper 1
Report on the Examination

7408
June 2019

Version: 1.0

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SECTION A

General Comments

Section A contained a range of question styles on a variety of topics that gave students many opportunities to demonstrate their knowledge and understanding. The major difficulties for them were seen in tests of Assessment Objective 3 (AO3). Many students found the requirement to make and justify a judgement particularly challenging. The failure of students to write clearly, both in terms of legibility and expression, is likely to have a bigger impact on questions like these. Much good work was seen, however, from those students who were clearly well prepared for this examination.

Question 1

1.1 This question was answered correctly by the majority of students. A common error was to omit detail, referring simply to a difference in the number of neutrons rather than saying clearly that Iodine-131 has 6 more neutrons. Occasionally students were confused between protons and neutrons, or simply referred to the number of nucleons. These responses did not gain credit.

1.2 Few students had any problem giving the correct answer to this question. In a small number of cases, the student gave too much information, so that it was unclear which part of it was their answer. In 'state' questions of this kind, students should be encouraged to write down just the answer expected, or at least to make the answer explicit.

1.3 Many students demonstrated a good understanding of electron capture and so obtained full marks. There was some evidence of confusion with beta decay, however. A surprising number of students referred to changes in the number of electrons within the nucleus and answers of this kind rarely gained any credit. The clearest responses referenced the nucleus clearly and stated what happened to the number of protons and neutrons. Vague answers tended to be unclear about which nucleus did what.

1.4 This question tested students' ability to apply their knowledge and understanding to an unfamiliar context. It was pleasing to note that half of the students were able to provide information on at least two differences. References to both processes were expected for each difference, although a missing reference was condoned in situations where no change occurred. Occasionally students gave the mediating particle and the fundamental force involved as separate answers, but this was only credited as one difference.

Question 2

2.1 Here the students were expected to refer to the normal, or to explain what the normal is. Answers that referred to the prism rather than the surface of the prism did not gain the mark.

2.2 A common error was to refer to the density of the material rather than to the *optical density* or *refractive index*; this prevented students from gaining the first mark. Answers that implied that there was material between the prism and windscreen did not gain the second mark, unless it was clear that this material also had the same refractive index.

2.3 Most students correctly calculated the critical angle for the first mark. Students did not gain further credit when it was unclear which angle had to be larger than the critical angle for total internal reflection to occur.

2.4 There were several routes through this question and all of them were seen. Most commonly, students demonstrated the idea that 45° was no longer larger than the critical angle. Some suggested that, with water present, not all light underwent total internal reflection (TIR) rather than referring to partial internal reflection; this prevented the award of the second mark. The suggestion that TIR occurred at the critical angle was similarly not rewarded. Incorrect answers referring to refraction and diffraction were seen but were rare.

2.5 A relatively common error in this question was the idea that the thickness of the glass varied, rather than the refractive index. The mark scheme allowed several routes to the first mark, with students either considering a change in direction within the glass or an effect at the boundary. However, some students suggested that the angle of reflection would be changed and, without reference to the angle of incidence, this did not gain credit. The second mark proved to be much more challenging and students rarely referred to the effect of the 'few percent' change in the question.

2.6 This question required students to make a judgement about the effect of the change on the sensitivity of the detector, and therefore answers that made no reference to sensitivity gained no credit. Many students were able to explain that, with multiple reflections, the ray was more likely to hit a drop. Students found the second mark point harder to access, often because of their answers were not expressed clearly.

Question 3

3.1 Although many students were able to recall the single-slit diffraction pattern for monochromatic light, there was confusion as to whether the filter transmitted or absorbed red light. Some students also suggested that the central maximum would be white, but the outer maxima would be green.

3.2 It was clear that many students understood the relationship between the angle of diffraction and wavelength, but some referred incorrectly to the Young double-slit equation to support it. Some students simply referred to the change in colour, without reference to the size and position of the maxima.

3.3 This calculation was clearly familiar to many students and most students received both marks. For the remainder, there was confusion between the number of lines per millimetre and the slit separation. This route leads to an answer of about 10^{-10} °. Students should be encouraged to check answers that appear unreasonable; this one clearly is.

3.4 Many students realised that the range of wavelengths would cause the point maxima associated with a diffraction grating to increase. What was less well understood was that this would not occur with the central maximum, as all wavelengths have a maximum at an angle of zero to the normal of the grating. There were several marking points for students to access, but the award of both marks was rarely seen.

Question 4

4.1 This question discriminated well. Students who argued in terms of the centre of mass were more likely to gain full credit. Although incorrect equations were not penalised on this occasion, teachers and students should be aware that this may not be the case in future examinations. A common error was the assumption that the centre of mass of the beam was 2.0 m from the pivot, or that the mass of the sling had to be considered, rather than the mass of the beam. A failure to express ideas clearly also cost some students marks.

4.2 There were five marks available for this extended calculation and almost half of the students obtained all five. The mark scheme allowed students to make errors in several parts of the calculation without over-penalising them. Common errors included missing *g* from the weight of counterweight stones, or using the incorrect angle for the component of the tension. Occasionally the distance to the rope was missed in the equation for the turning effect of the tension. In multi-step calculations of this kind, students should be encouraged to set out their work logically and make it clear what they are doing at each step so that consequential error marks can still be awarded.

4.3 This two-step calculation was completed correctly by many students, and those who made an error in the calculation of the time still had access to the second mark point.

4.4 Despite the fact that this question assessed AO3, a range of good answers were seen. Generally, students realised that the vertical velocity would cause the time of flight to be longer and then linked this to an increase in range. Some answers were less clear, and it was sometimes difficult to understand whether the student was arguing for or against a range increase. Students who suggested that a shorter time of flight would occur did not gain credit.

Question 5

5.1 This very straightforward calculation was answered correctly by the vast majority of students. An occasional error was the failure to convert the speed to metres per second.

5.2 This calculation was slightly more demanding, with some students attempting to use the energy given to them in the previous calculation. This approach, whilst unnecessarily long, did gain full credit when carried out correctly. One common error was the use of sine rather than cosine when calculating the momentum, or omitting the mass altogether. Another common error was the use of N m for the unit, suggesting some confusion with energy.

5.3 Students managed to find some very different approaches to what is essentially a straightforward multi-step calculation. Answers that appeared to be taking a component of the kinetic energy, and therefore treating it as a vector, did not gain full credit.

5.4 AO3 questions of the type in question 5.4 leave students free to choose the approach they wish to take. Each approach was treated on merit and was awarded full marks if correct. The most common, and successful, approach was a consideration of the work done by the barrier and therefore the average force that needed to be applied by the barrier to remove the perpendicular component of the car's velocity. Occasional errors were related to incorrect physics, for example using the wrong *suvat* (kinematic) equation, or errors in algebra and computation. Unfortunately, many students were unable to see a way through this question that gave them any credit. This may have been due to students giving up or to them being unable to achieve the 'show that' values given in previous parts. Students should be encouraged to make use of the 'show that' values in these instances as they are there to allow access to later questions.

5.5 This question had several routes to the correct answer, the most popular being the consideration of time and an impulse route, or the consideration of distance and a work done route. Less commonly a route involving Newton's second Law of Motion was seen. A failure to express ideas clearly was the most common reason why students did not achieve full credit here.

Question 6

6.1 This question caused no problems for the majority of students. Common errors were confusing the negative and positive velocities (giving an answer of 0.5 ms), or treating Figure 8 as a *v-t* graph (giving an answer of 2.0 ms).

6.2 Students who did not obtain full marks on this question tended to make mistakes reading the axes, for example using 4.1 mm for the displacement, or using the wrong power of ten in the final calculation. A surprisingly large number of students simply divided the maximum displacement by the time and received no credit.

4.3 Most students were able to identify the wave as longitudinal. Lack of clarity meant that fewer were given the mark. In particular, it was unclear what was oscillating (the particle) and what was propagating (the energy). Suggesting that the particles move in the direction of energy propagation was not credited, as there was no suggestion that the particles also move in the opposite direction; however, 'parallel to' and 'along' gained credit.

Question 7

7.1 The determination of the internal resistance and emf of a cell is a practical experiment students are required to undertake when studying this specification. The reference to a *practical* circuit should have alerted students to assume that the internal resistance of the cell must be taken into account. Students who were sufficiently familiar with the phenomenon were unlikely to have much difficulty with this question. However, big gaps in the knowledge and understanding of electricity were seen in the answers given by many students. Most students are familiar with the idea of increasing current and potential difference (p.d.) through $V = IR$. However, presented with the apparent paradox of increasing current and decreasing p.d., many students could not cope. It should be stressed that students should assume a cell has internal resistance unless otherwise stated explicitly in the question. It is unlikely that a resistance symbol will be added to the circuit diagram to indicate the presence of internal resistance. Those students who gained one mark for their answer usually did so by stating that the current through the lamp increased.

7.2 It may have been expected that combining cells in parallel would have encouraged some idea of internal resistance amongst the students, but this was rarely the case. Many students ignored the reference to parallel circuits and gave an answer that suggested that the cells were in series. Students will have studied simple circuits as part of their GCSE course. The inclusion of internal resistance is one of the ideas that sets the A-level electricity content apart from the earlier qualification. Students should be given opportunities to explore internal resistance and its consequences in a variety of contexts.

SECTION B

This report will not go into a detailed analysis of the questions in this section, but some points, that may prove helpful to teachers and students, are identified.

The most demanding questions proved to be 26, 15 and 30. Questions 19, 32 and 22 also proved to have popular distractors.

26 Less than one third of the cohort identified A as the correct answer to this question. The most popular distractors were B and D, presumably due to students not realising that the resistance of T decreases as its temperature increases.

15 This question was answered correctly by less than half of the students. By far the most popular distractor was C. Had students chosen to draw a small force diagram, it may have helped them to determine the sign of the different forces in relation to the acceleration and thereby obtain the correct answer.

30 This was answered correctly by less than half of the students. D was the most popular distractor, with some students probably calculating the number of oscillations of B. A and B were also relatively popular.

19 The majority of students got this question correct. Option B proved to be the most popular distractor, with about 25% of the students choosing it. It is likely that students made a power of ten error converting square millimetres into square metres.

32 Most students correctly identified D as the correct answer here, but B also proved to be popular with about 25% of the students. They may have realised that the amplitude decreases with damping, without taking into account peak broadening.

22 The most popular distractor here was C, with about 25% of the student choosing it. This may be due to some of them taking a clue from the unit without considering the actual value of the kinetic energy.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, these data still give a true account of how students have performed for each question.

Mark Ranges and Award of Grades

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