AQA

A-LEVEL
PHYSICS

7408/1
Report on the Examination

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General Comments

All questions were found to be accessible with no question standing out as being particularly more or less challenging than the others. However, one part in each of questions 1, 5 and 6 did prove to be difficult and led to relatively few gaining full marks for those questions. Questions 1 and 5 required students to consider or analyse unfamiliar contexts and whilst many made some progress, relatively few could provide convincing responses. The final part of Question 6 was different from the other two in that it was set in a context that should not have been unfamiliar. The problem for students here was that they were required to give a qualitative response to the question whereas they may have previously come across similar questions requiring numerical analysis. This led to responses that made no sense in terms of the momentum and energy conservation.

The structure of numerical responses from many students was very good, such that examiners could readily follow the steps to the answer. Unfortunately, this was not the case for others who let themselves down with working which consisted of random calculations with no clear link between them. This led to a failure to gain many 'intermediate' marks, especially when the answer was incorrect. The process of quoting the formula to be used, followed by substitution of data (taking care with prefixes) and then computation of the intermediate or final answer should be familiar to students at this stage in their studies of the subject.

Section A

Question 1

01.1 It was important to realise that this was not uniform deceleration so that application of the *suvat* equation was not appropriate. Many students unfortunately used this approach and therefore could only access the final mark for application of $F = ma$. A significant proportion used the instantaneous values at 2 s to find acceleration and these students were denied access to the final mark. Students who realised that a tangent was required were able to progress and were rewarded, provided that the tangent was not at a point too far from 2.0 s. The accepted range was determined to allow for the acceptable limits. Just over 30% of students scored all three marks.

01.2 The use of the *suvat* equations led to no marks being awarded in this part. A majority of the students realised that the area under the graph was needed and there were many very sound responses (though 65% of students ultimately scored zero). Counting squares was the most popular approach. Use of the trapezium rule was often spoiled by choice of time intervals that were too large.

01.3 Students here needed to think of the context and respond accordingly. There were many who produced the very low level response of 'heat and sound', which gained no credit. It was essential to state what was heated. Only the more thoughtful students commented on the transfer of KE of the lorry to KE of the gravel, or work done moving it, which contributed to the greatest energy transfer in the context. 4.6% of students gained both marks here.

01.4 There were a number of different routes that led to the conclusion that the escape lane was long enough and they were seen in fairly even numbers. The easiest and possibly most straightforward were a comparison of the initial KE of the lorry and height at which the KE would be totally transferred, or comparison of the initial KE with the PE of the lorry if it were to reach the top of the ramp. Whilst the appropriate calculations were often seen, it was disappointing that many did not provide any comments of what each calculation represented and final statements in conclusion were often not well argued. However, over a quarter of students were able to score maximum credit.

01.5 This was an open-ended question that could be argued either way with appropriate comment. The most common approach was to discuss the problem of rolling back down the slope after stopping on the ramp. Comments relating to comparisons of acceleration were not appropriate as this usually led to students writing that the deceleration was lower on the gravel. These were comparing the instantaneous deceleration at 2 s with the uniform deceleration on the ramp; the initial deceleration on the gravel was considerably larger. 52.5% of students answered this successfully.

Question 2

02.1 This was often well answered (63% of students gained both marks), although presentation of the work left much to be desired in many instances. Conclusions were often vague or non-existent (e.g. a series of ticks), rather than a convincing statement. Questions of this type are quite common in examinations and a provide a useful skill in testing practical data. Using a 'known' equation and data to demonstrate that the numbers are compatible is not an acceptable approach.

02.2 For full credit in this part it was necessary to provide some evidence of working. It was well done by a majority of the students; over 80% scored two marks.

02.3 The fact that diffraction or interference is a wave property and explaining how wave theory explains the bright rings were the two most common points made. To gain full credit, either an explanation of what would be seen if electrons behaved as particles or an explanation of what is meant by diffraction and where it occurred was required. Neither of these was commonly seen in students' responses.

02.4 Most answers missed the point of the question. There were many responses that explained the excitation and de-excitation process, some in much detail, but did not explain clearly that the energy transfer to excite the electron in the atom has to occur with an exact amount of energy being supplied to the electron instantaneously. Many students quoted a 'one to one interaction', but this seemed to be a learned response and provided insufficient evidence of them understanding what this means.

Question 3

03.1 This was well answered by many students (47.5% gained at least two marks here), but there were also many responses that presented ambiguous or unclear statements. Those students who only referred to reflection of the wave at one of the fixed points had difficulty expressing clearly that there are two waves moving in opposite directions that superpose. The clearest answers referred to the wave produced by plucking travelling to both fixed ends of the string where they are reflected and then superpose, followed by an explanation of the interference ideas that produce nodes and antinodes.

03.2 This was answered very well by a great majority (81.1%) of the students.

03.3 All the data needed to do this were readily available to substitute in $v = f\lambda$. Determining the correct value for λ (0.33 m and 0.165 m were often seen) led to most incorrect answers.

03.4 Most students appeared to appreciate the process that needed to be followed to arrive at an answer and many were able to follow this through to a successful conclusion. In general terms, knowing how to determine circumferences and areas of 2- dimensional objects, and circumference, surface areas and volumes of 3-dimensional objects is fundamental in almost all topics in physics. Those who made little progress did not have this basic understanding. In this question, the circumference of a circle was the basic knowledge needed and how to determine the length of an arc of that circle. The other issue for the first step was to read carefully what information had been provided; in this instance diameter, not radius. In the next step, misreading the scale of the extension axis was a common error. The frequency calculation was then straightforward. Many students did not know what to do about the length, not appreciating that the vibrating length was unchanged when the peg was turned. The extension was added and occasionally subtracted from the length of 0.33 m, but this was condoned as 'specialist knowledge'.

Question 4

04.1 The problem that has been discussed in question 03.4 was evident in this question too but there was a high proportion of correct solutions (58.9% scored full marks) to this relatively familiar problem.

04.2 Many students were able to make some progress by doing a relevant calculation. The most common one was to calculate the pd across the resistor that would produce the maximum power dissipation of 0.36 W in the 025 kΩ resistor. However, very few could follow this up with a sensible conclusion. The most common statement was that since the pd from the calculation was 9.5 V, the resistor would be unsuitable as the 0.25 Ω resistor would not be operating at its rated power. What students needed to state was that it is suitable: since the maximum pd possible for the circuit was 9.0 V, the maximum possible power dissipated in the resistor (0.32 W) was lower than 0.36 W. There were other possible useful calculations, but providing a clear correct conclusion was relatively rare. Just under a quarter of students gained both marks.

04.3 This was generally answered well and there were many completely correct responses including the significant figures in the final answer (27.6% of students). There were, however, many who complicated matters by trying to do all the algebra first. These students combined the formula for the parallel resistors and the potential divider aspects into one equation. This often led to a page of manipulation and frequently errors crept in. Those who wrote $\frac{1}{R} = \frac{1}{R} + \frac{1}{750}$ for the parallel resistors ended up with difficulties as they lost track of which R represented the total resistance of the parallel combination and which was the resistance they were trying to determine. Students who first worked out the resistance of the parallel combination from the potential divider formula (or otherwise) and then used the formula for parallel resistances could complete it in a few lines and avoided these mistakes.

04.4 Many students appreciated that the thermistor resistor would decrease, but fewer gave a satisfactory explanation of why this led to the decrease in output voltage. There were many misconceptions shown in the responses. One which was quite common was "because the resistance of the thermistor decreased, the pd across it would decrease therefore there would be more of the pd across the other resistor therefore a higher output potential difference". Just over a third of students failed to score on this question.

Question 5

05.1 Many students (59%) completed this part fully successfully. This and part 05.2 exposed weaknesses in the understanding of some students when using sine, cosine and tangent. Many who arrived at 2.71 m did not add the extra metre for the platform to deduce the radius of the circular path followed by the acrobats.

05.2 The simplest and most common route to the answer was to consider the vertical forces. There were other routes to the answer too. The most common of these was to realise that the horizontal force due to the tension provided the centripetal force. Examiners allowed the error carried forward from 05.1 for the radius of the path for those who solved the problem this way.

05.3 There were some very good responses to this part and many students provided at least part of the necessary analysis. A high proportion of students wrote that there would be unbalanced forces on the acrobat, but in the subsequent explanation of how this imbalance occurred many answers were spoiled when students wrote about effects of weight when they should have referred to mass and vice versa. Most responses concentrated on the unbalanced horizontal force or considered the moments of the forces. Few made any comment of the increased vertical force on the pole.

Question 6

06.1 That kinetic energy would be conserved in an elastic collision was well known (64.5% correct).

06.2 Most students knew how to arrive at the answer (75.3% fully correct), but responses were often completely unstructured and consisted of a mass of figures and calculations with no indication of what the calculation represented. In questions where the command word is 'calculate' this may often be accepted, but in 'show that' items communication of the processing of data needs to be clear.

06.3 The same impulse on each of the trucks is equal and opposite so students needed to focus on one or other of the trucks involved. There were many who misread the data and associated the initial velocities with the wrong trucks. Many gave the impulse as the difference between the final momenta of the two trucks.

06.4 It was necessary here to have a qualitative appreciation of the application of conservation of momentum and kinetic energy in the elastic collision. It is not possible to conserve both unless the trucks travel in opposite directions after the collision, and many appreciated this point. Many students, however, went on to state that the speed of each truck would be the same as before but in the opposite direction; others wrote that B would have the speed that A had and vice versa. The first conserves kinetic energy but not momentum (total momentum would be reversed) and the second would only be true if they had the same mass. If A were to stop, as suggested by many students, then to conserve momentum B would need to travel at a lower speed than either of the trucks (since the initial total momentum was 7600 Ns to the right, B's speed would need to be 0.63 Ns). This would not conserve kinetic energy. 38.5% of students were successful here.

Section B

The 25 questions in Section B are summarised in the table below. For each question, the key (correct answer) is provided, along with the percentage of students answering correctly. There was a good range of 'facility' across this section; the most accessible questions were 12 and 18 (both answered correctly by 89.2% of students), the least accessible was 20 (answered correctly by only 38.1% of students). The overall mean mark achieved by the students for Section B was 15.7 out of 25 (62.8%).

Question	Key	% correct	Question	Key	% correct	Question	Key	% correct
07	B	67.6	16	D	74.9	25	C	58.3
08	B	46.6	17	B	83.2	26	B	75.4
09	C	75.2	18	D	89.2	27	D	46.1
10	C	46.1	19	D	48.8	28	C	76.3
11	A	68.0	20	D	38.1	29	D	48.0
12	B	89.2	21	D	43.0	30	A	66.6
13	B	68.6	22	C	56.7	31	D	74.3
14	A	76.5	23	C	70.2			
15	C	78.0	24	D	44.5			

Mark Ranges and Award of Grades

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