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General Certificate of Education

Physics 1451

Specification A

PHYA2 Mechanics, Materials and Waves

Report on the Examination

2010 examination - January series

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Dr Michael Cresswell Director General.

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General Comments

This paper was slightly more demanding than the previous two PHYA2 papers. This was due to the fact that several of the questions were set within contexts that demanded careful interpretation by the candidate. The grade boundaries were therefore slightly lower for this paper.

The paper provided opportunities for candidates to demonstrate their knowledge and understanding across all of the topics detailed in the specification.

The average mark in this paper was lower than the June 2009 examination. There was a fairly even balance between written responses and calculation on this paper. As in June, the majority of candidate's marks were scored on successful calculations rather than on the questions requiring written responses.

Some questions attracted excellent responses from many candidates. In particular, these were the mechanics calculations on question 1 and the questions about waves. Candidates again found refractive index calculations straight forward; question 4 on stationary waves attracted very good responses from candidates across all abilities and the Young's slits calculation in question 5 was done well.

There was some evidence that candidates are not as well prepared for this examination in January as they are in June. For example, question 6 (a) required candidates to discuss the measurements needed to find the Young modulus. This measurement technique is mentioned in the specification, yet the quality of answers was generally rather disappointing. A similar question in June attracted generally superior responses. Definitions had not been learnt well by many candidates and only about 10% managed to get all four marks for these parts. Another question that should have been fairly straight forward that did not get as many good responses as expected was question 2 (a)(iii). This was a Law of moments question that required a very standard approach in order to produce an answer. Perhaps candidates did not do as well as expected on this question as there had not been a similar question on which to practice on either of the first two PHYA2 papers.

Question 1

In part (a)(i), most candidates quoted the equation and correctly calculated the time. The most frequent misconception was the belief that a 'suvat' equation should be used even though the velocity is constant.

The correct answer of 3000, or 3022, was accepted in part (a)(ii) and the majority successfully produced this value.

In part (b)(i) most select and quoted the correct equation and showed the correct substitution. Some lost the mark as they did not show the answer to more than one significant figure.

Part (b)(ii) was a very easy question for over 40% of candidates who understood that the horizontal acceleration was zero. For these students, $45.3 \times 0.685 = 31$ gained two marks. However, 13% did not attempt the question and another 40% misapplied a kinematics equation to the situation often using 9.81 as the acceleration.

The vast majority of candidates identified air resistance as the key factor to part (b)(iii). However, only 7% mention that **horizontal** deceleration is caused by air resistance.

Question 2

In part (a)(i), the majority of candidates stated 'force × perpendicular' distance but only 16% stated the full definition. Many did not recall the definition accurately or did not say the distance was between the line of action of the force and the point. Many said 'force × perpendicular distance from the line of action' or 'force × perpendicular distance to the point'. These candidates were only awarded one mark.
A significant number of candidates stated the Law of moments rather than the definition of a moment and some produced a vague description of a turning effect rather than a definition. Students should be encouraged to learn the full definition off by heart.

In part (a)(ii) 57% scored two marks very easily. However, a surprising number selected the front springs rather than the rear due to 'a larger distance from the pivot causing a greater moment on the front'; confusing the *centre of mass* with the 'pivot'. Some candidates assumed the *centre of mass* is always closer to the front of a truck. However, the question shows a rear-engined pick-up. Some candidates thought that the rear springs were 2.0 m from the *centre of mass* having incorrectly interpreting the dimensions on the diagram. Some felt that since the truck was in equilibrium, both sets of springs would be equally compressed.

For such a simple moments question, part (a)(iii) was done poorly by the majority. Perhaps the context made it seem more difficult than it really was, but many chose the wrong distances and equated a moment with a force rather than another moment. Common incorrect answers were $14000 \times 1.4 = 19600$ and $14000 \times 1.4 = 14000 \times 1.1$. Many common answers given were greater than the weight of the truck. Most of those who couldn't pick up any marks for the moments calculation did realise that it would be necessary to divide by two at the end and so most scored at least one mark.

In part (b) most gained two marks with the error carried forward from their previous answer.

The poor response to part (c) was very surprising. Only 5% gained two marks with 47% getting zero and 18% not attempting the question. Perhaps those who had struggled on previous parts of this question made the assumption that this would be difficult as it was the final part of the question. However, it was perhaps the easiest part of the question and was independent of the previous parts.

Question 3

In Part (a)(ii) nearly 50% of candidates did not score any marks. Many did not show the ray deviating towards the normal as it entered and many showed it bending away from the normal. It was common to see the reflected ray at a noticeably different angle to the incident. A significant number did not use a ruler.

For part (b), some candidates rounded to 0.986 before calculating the angle which was penalised and a significant number gave an answer to four significant figures which was also penalised. However, the majority gained both marks here.

About 30% mentioned multimode dispersion or signal loss in part (c), but only a few picked up the second mark for explaining the consequence of this.

Part (d) was very easy and most candidates picked up both marks. Typical answers described the benefits of endoscopy or high speed internet.

Question 4

In part (a)(i), about 60% of candidates drew one 'loop' and picked up the mark. However, we were fairly lenient on the shape of the 'loop' and students need to practice drawing these shapes.

Part (a)(ii) was expected to be a little easier than it was. 42% scored no marks on this despite the benefit of an error carried forward from an incorrect part (a)(i). Many did not realise the wavelength was found from the length of the string and knowledge of the shape of the fundamental. Some candidates used $\lambda = v/f$ with v = speed of light. In contrast, most candidates found part (a)(iii) a very easy calculation.

The majority of candidates got four antinodes in part (b)(i), but then nearly half of those lost the second mark by either not sketching the curve carefully enough or, more commonly, forgetting to label the antinodes.

In part (c), the vast majority correctly suggested tightening or shortening the string. A few thought that plucking harder would increase the pitch and some suggested increasing the length, using a thinner string, increasing the wave speed, or even 'play faster'.

Question 5

Part (b)(i) was the definition of monochromatic. Most had no problem with this but a significant number simply said 'one colour' and this was not enough.

In part (b)(ii) 'constant phase relationship' or 'difference' was expected but many candidates said 'in phase' which was not given credit.

80% picked up the mark for a sensible suggestion in part (b)(iii) such as 'never point the laser at someone'. The other 20% suggested 'goggles', 'safety goggles', 'tinted goggles' which was not enough. A few candidates said 'specialised goggles' or 'goggles designed for use with lasers' which was given credit.

Part (c) was a calculation using the two slit formula. 35% scored full marks. Common errors included converting 0.30 mm to 3×10^{-3} m, using 0.16 as w, or using w = 0.16/9 rather than 0.16/8 due to counting dots rather than gaps and incorrectly rearranging the formula.

In part (d), the majority of candidates scored the first mark but were unable to explain why in a convincing manner.

Question 6

Part (a) assessed the candidate's quality of written communication. Most responses were lacking in detail and there was a general lack of awareness of what is required in a question such as this. The question asked how the **data** to determine the Young modulus could be obtained accurately. A good response would mention the quantities needed and the measuring instruments required with an indication of how the apparatus is arranged.

Many candidates did not list all the measurements (original length, extended length, diameter) or the quantities derived from these (extension and cross sectional area) that would be needed for the calculation of Young modulus. Failure to state that diameter or cross-sectional area would be measured limited the candidate to two marks out of six.

Candidates were also expected to make a comment about accuracy and to get beyond two marks they needed to mention some form of repeat or the use of a range of masses or the use of a wire of 1.0 m or more.

The specification states that candidates should know a simple method for the determination of the Young modulus. This implies that they do not need to be familiar with Searle's apparatus. Some candidates scored well when giving a detailed account of Searle's. However, those who seen Seale's apparatus but only partially understood how to use it, tended to fare less well than those who described stretching a wire along a bench. It should be noted that the phrase 'simple method' does not imply that a non-graphical method will suffice. Many candidates described substituting one-off measurements into the Young modulus equation. An accurate method, at least in a school laboratory, should involve using a range of loads and extensions. We would recommend that centres who have Searle's apparatus do demonstrate it and give students the opportunity to use it. However, the simpler method of stretching horizontally on a bench can be presented as the preferred option for a descriptive question such as this for all but the most able and meticulous students.

Diagrams produced by candidates here tended to lack detail and labelling and many did not go on to state that the load or force had to be found from the mass.

In part (b)(i), the line of best fit was drawn well by 55%. Some drew a straight line but did not produce a curved section at the top. Some did not draw the line going through the origin. However, it was felt that in this case candidates should expect a stress-strain graph to go through the origin and should have extended to the origin. Best fit lines are taught extensively at KS3 and KS4. However, the evidence suggests that candidates continue to lose marks on these at AS level so a lot of practice is needed.

For part (b)(ii) most candidates did very well and picked up three or four marks. A significant percentage of candidates who had drawn an incorrect best fit line did pick up full marks for the gradient calculation. Of those who did not, many chose the wrong unit eg Nm^{-1}, Nm or 'pa' rather than Pa. Some candidates could have been awarded a method mark if they had drawn a triangle as evidence that they where calculating the gradient. Many candidates could have set out their answer in a much clearer manner.

Question 7

Part (a)(i) was a fairly easy two marks for the majority of candidates. Most gave 420000 but about 10% omitted this and lost one mark.

Part (a)(ii) was straight forward for most but a common error was the use of the volume instead of the velocity.

For part (a)(iii), perhaps 10-20% didn't know 'M' was 10^6. Quite a few divided by 10×10^{-6}. About 14% left this question out, either indicating that they had run out of time or they had forgotten how to calculate efficiency. About 43% gained full marks.

Perhaps candidates pressed for time had spotted part (b) and sensibly decided to skip part (a)(iii) and pick up this little gift instead; still a little surprising that only 56% managed to get both marks even though 95% attempted the question.

Mark Ranges and Award of Grades

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