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# Physics A PHYA2

# (Specification 2450)

# Unit 2: Mechanics, materials and waves

# *Report on the Examination*

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**GCE Physics, Specification A, PHYA2, Mechanics, Materials and Waves**

**General Comments**

This paper provided opportunities for students to demonstrate their knowledge and understanding across a wide range of the topics detailed in the specification for the Mechanics materials and Waves unit. There was a good balance between written answer and calculation on the paper.

Slightly higher marks were gained on this paper compared to the summer 2011 paper. This was mainly because many students found the six mark extended answer question very accessible.

There was evidence that many students had prepared well for this paper. Students were again most successful when answering questions similar to those found on recent past papers and they fared less well when faced with a 'new' question such as the one on aerial alignment.

Several of the questions were set within contexts that required careful interpretation and application of knowledge as required by the specification.

There was an even balance between questions requiring written responses and those requiring calculation, with roughly half the marks associated with each. The most successful students were able to perform well on both types of question.

Many students performed very well on this paper and produced impressive responses that highlight the high quality of teaching that they have encountered. However, the comments below will focus mainly on the common incorrect responses as this will help teachers quickly pinpoint areas for improvement.

**Question 1**

Parts 1(a)(i) and (ii) in general were well answered. Typical mistakes included: weight being given as a scalar and speed as a vector.

Part 1(b)(i) was answered very well apart from some students accidentally writing the forces the wrong way round. In part 1(b)(ii) many students didn't realise the significance of the closed triangle though most realised the forces were in equilibrium. This was surprising because the idea of a closed triangle of vectors is mentioned in the specification.

Many wrongly chose to use cos74 rather than sin74 in part 1(c) but most did correctly round to 2 significant figures.

**Question 2**

The answers to part (a) were generally very detailed with many students continuing to write to the bottom of the page. Answers could have been more succinct perhaps. eg *No energy lost, so all GPE at A is converted to KE at B which is converted to back to an equal amount of GPE at C*. Some students explained that GPE transfers to KE but then failed to mention the conversion back to GPE. eg 'all the GPE is converted to KE at B, so it gets to the same height at C'. Often the law of energy conservation was quoted but they did not explicitly state that there were no energy 'losses' due to no friction or drag.

In part (b) there was some carelessness in the positioning of the label for B. Many students had a significant straight section at the start and showed the ball decelerating after point X.

In part (c) students often stated that the speed was constant but did not point out that the ball would move in a straight line. They often explained the motion in terms of there being 'no forces' acting on the ball rather than 'balanced forces'.

**Question 3**

For part 3(a)(i) most students successfully gained the unit mark here, but a few put $Nm^{-1}$, N/m, NM or $Nm^{-2}$. In part 3(a)(ii) students fared better on this moments problem than we have seen on previous papers. However, there were still plenty of problems. In particular, some students are unable to identify clockwise and anticlockwise moments. It is perhaps surprising how many AS physics students do not understand the concept of a moment and are unable to identify the direction of rotation that it would cause about a given point if no other forces acted. One possible strategy is get students to identify the clockwise and anticlockwise moments in many situations before teaching them how to use the law of moments. There were also a lot of mathematical errors by those who had equated the moments correctly and then could not rearrange correctly. Many rounded 97.46 to 97.5 and then rounded again to 98. For part 3(a)(iii) most were successful. Very few resorted to an unnecessary moments calculation for this one and many picked up the mark for an error carried forward if their previous answer had been wrong.

In part 3(b)(i) nearly all students were successful here though some used *s* rather than 2*s*. In part 3(b)(ii) a significant number of students used 520N as the mass, not realising it was necessary to divide the weight by 9.81 to get the mass. Some multiplied by 9.81 instead of dividing. However, this was an easy two marks for most.

**Question 4**

In part 4(a)(i) a significant number of students did not know 'cladding' and in part 4(a)(ii) the majority got this one correct. However, a significant number had their calculators in radians mode and gained 1 mark for the correct working but got a wrong answer of 1.31. Some rounded prematurely (eg 1.41/1.46 = 0.97 which leads to an answer of $76^o$ rather than $75^o$). When using the inverse sine function it is important that the value used has not been rounded to less than 4sf.

Quite a few students gave an answer of 85-30=$55^o$ or 90-30 = $60^o$ for part 4(b)(i). In part 4(b)(ii) most students do very well on Snell's law questions. Those who got the wrong answer for 4(b)(i) often got full marks here with the error carried forward taken into account. Some did get the refractive indices the wrong way round or omitted the 1.46 – presumably thinking they were calculating a critical angle for a glass / air boundary.

In part (c) many students thought that rays would refract 'when the critical angle is exceeded'; perhaps associating a large angle with being 'too big'. Many thought that a ray will travel further in a wide core. It will actually travel the same distance if the angle is the same.

**Question 5**

The 6 mark extended answer for part (a) included a quality of written communication assessment. The question seemed familiar to the majority of students of all abilities and many gained 5 or 6 marks. Nearly all mentioned the use of a rule to measure the extension which was essential to gain 4 or more marks and the majority described a correct graphical method which allowed access to 5 or 6 marks. It is still the case, however, that not enough students make suggestions about the range and number of readings they would aim to record. Some who do suggest a number of readings seem to believe that the ideal number is 5. However, one would always aim for more unless it was impossible to do so – ten to twenty readings would be sufficient here. It was surprising how many students believed it was necessary to verify the elastic limit by increasing the load beyond 20N – that was not the question.

For part 5(b)(i) some students did not know how the parallel arrangement changed the spring constant. In part 5(b)(ii) many did not double the extension (or half the spring constant) here and got no marks. Those who understood that the spring constant would be halved tended to get both marks. Some thought the spring constant would double with two springs in series. In part 5(b)(iii) it was necessary to use $W=½F\Delta L$ with the extension from 5(b)(i). Many did this successfully but some then felt the need to then double the answer due to there being two springs. In part 5(b)(iv) many students did realise that the extension was greater for the series arrangement but they failed to point out that the load was the same for both series and parallel.

**Question 6**

Part 6(a)(i) was almost universally misinterpreted due to a similar question appearing on a previous paper. Many students interpreted the question as 'describe the motion over the next cycle'. Those who did this often failed to point out that there was a continuing oscillation taking place. Part 6(a)(ii) was very poorly answered which was a surprise. A common answer was 'out of phase' for X and Y which is not equivalent to 'antiphase'. Phase was often given in terms of number of wavelengths, e.g. ½λ. There was little understanding of the difference between phase difference along a progressive wave and a stationary wave. Many had measured the fraction of a wavelength between the points and converted this into an angle as you would for a progressive wave. It is suggested that phase difference along a stationary wave be demonstrated by referring to the many simulations available.

Part 6(b)(i) presented few problems for students. In part 6(b)(ii) many students did 1/780 and obtained the time for one complete cycle but did not recognise that they needed to divide by 4 to get the time for ¼ of a cycle. A significant number thought that the time between maximum displacement and reaching the equilibrium position was half a cycle. Some divided 780 by 4 which makes the answer 8 times greater than it should be.

For part 6(c)(i) most students got 'antinode' but a significant number put 'node'/ 'amplitude'/ 'max displacement' / 'stationary wave' / 'equilibrium' / 'maxima'. Part 6(c)(ii) presented few problems for students. In part 6(c)(iii) quite a few students left this blank because they were unable to answer the previous question. However, many of those who scored the mark did so by using an incorrect answer to 6(c)(ii). Students should be encouraged not to give up; the final part of a question is not necessarily the hardest.

**Question 7**

Most did well in part 7(b)(i) and indicated a complete wavelength very precisely, though a generous tolerance was allowed. A significant number thought the coils constituted the waveform and gave the spacing between one or two coils as the wavelength and some chose the compression or the rarefaction or the whole length of the spring. In part 7(b)(ii) many believed point P would move downwards. This is a very common misconception and a similar question has appeared in a past paper. The behaviour of point Q is more difficult to understand. The particle changes direction when the centre of a rarefaction or compression reaches it. If the wave is moving to the right, then as the compression gets closer to the particle, the particle will move left towards the compression.

In (c) the majority of students surprisingly did not recognise that this was about polarisation. Those who did point this out did not describe the aerial being aligned with the plane of polarisation.

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