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Physics A PHYA2

(Specification 2450)

Unit 2: Mechanics, materials and waves

Report on the Examination

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General Comments

This paper provided opportunities for candidates to demonstrate their knowledge and understanding across a wide range of the topics detailed in the specification.

There was evidence that many candidates were well prepared. Calculations were laid out in a neat and methodical manner. In written responses there was considerable awareness of the level of detail required. There was more evidence that basic definitions had been learned but there was still a lack of awareness of how to round an answer to an appropriate number of significant figures.

Many candidates coped well with calculations, but a significant number of candidates wrongly substituted numbers into equations without understanding what they were doing. This was especially evident on questions 1 and 2.

On balance the paper was slightly less demanding than the January 2010 and June 2010 papers and as a result of this the grade boundaries are slightly higher. Several of the questions were set within contexts that demanded careful interpretation and application of knowledge. To prepare for this type of question, students must be encouraged to practice as many exam style questions as possible. There was evidence that candidates have benefitted from practicing past papers. For instance, the definitions of coherent light and Hooke's law were answered well compared to when the same questions appeared in recent papers.

Candidates continue to be surprisingly poor at describing energy changes. 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 candidates were able to perform well on both types of question. In general, the majority of candidates' marks were scored on successful calculations rather than on the questions requiring written responses. However, compared to previous papers, more candidates performed well on the written responses involving reasoning and factual recall.

Many candidates performed very well on this paper though fewer than expected scored beyond 60 of the 70 marks available. However, the comments that follow will focus mainly on the common incorrect responses to help teachers quickly pinpoint areas for improvement.

Question 1

The definition of Hooke's law in part (a) (i) was done very well. Some missed the second mark by not mentioning the *limit of proportionality*.

Most candidates pointed out that the line was straight in part (a) (ii), but many did not score the second mark for saying that the line passed through the origin.

In part (a) (iii) many candidates either gave incorrect units, including Pa, J, Nm, or no units at all. Most correctly calculated the gradient, though some did not use a wide enough range to score full marks.

For part (b) (i), most candidates pointed out that energy stored is found from the area and that area is half base times height for a triangle. For the third mark, it was necessary to relate the area to the *work done* and this response was rarely seen. Work has been done on the spring to compress it (or work is done by the spring if it is being released) and the area represents the work done and therefore also the energy stored. Some lost marks because they explained how to calculate energy from the graph rather than how to derive the equation.

Surprisingly, only a relatively small number of candidates got full marks on part (b) (ii). Many used $P=Fv$ or $P=W/t$ and did not realise they would need to half their answer. A surprising number misread the force from the graph as 340 N, 370 N or 380 N rather than 360 N for instance. Another common error was to divide force by time (360/1.5) believing 360 to be the work done.

Question 2

The majority of candidates were successful in part (a) (i). A few worked backwards by substituting 3.7 and getting 67.15 m. This only received two marks if there was a clear statement that this showed 3.7 to be the correct time. Candidates should be encouraged to write down their answer to more than two significant figures for 'show that' questions like this one, although this was not penalised here.

A very large number of candidates expressed their answer to part (a) (ii) to three significant figures (eg 40.5) rather than two significant figures. Many used 67 m instead of 150 m. As a result, few gained both marks.

The majority gained two marks in part (a) (iii). A common incorrect answer was v = 67/3.7 = 18, where candidates were not aware that this was not appropriate for constantly accelerated motion.

Most candidates realised that Pythgoras' theorem was needed in part (a) (iv). However, a surprising number incorrectly used the values 150 m and 67 m, rather than their answers to parts (a) (ii) and (a) (iii). Many candidates gave bearings from north instead of an angle from the horizontal or vertical. The best way to convey direction here would be to calculate the angle and then show this on a sketch and also write 'angle from horizontal'. If there is not a clear diagram then the candidate would need to say 'from the horizontal and downwards to the right' or words to that effect.

Very few candidates had a problem with part (b) (i).

For part (b) (ii), there was some confusion about energy changes. Most candidates mentioned transfer of PE to KE but did not go beyond 'energy lost due to air resistance' and did not gain the second mark. The question asks for 'energy changes' so they needed to say *kinetic energy* changes to *internal energy* (*heat*/*thermal* are also accepted at AS). Some described the motion in terms of forces, velocity and acceleration – these gained no marks. Quite a few described the kinetic energy changing to gravitational as the cannonball emerges from the cannon.

Question 3

Most candidates gained at least one mark in part (a) for showing that the intensity of peaks reduced with distance from the centre. However, many did not recall the key difference between the pattern for single and double slits – the single slit pattern has a central maximum which is double the width of the subsidiary maxima.

There were many correct definitions of monochromatic and coherent in part (b). A few stated 'same colour' for monochromatic and 'in phase' for coherent. Neither of these were accepted.

In part (c), many candidates incorrectly used the equation for two slits to show that the maxima were further apart. This was not penalised since an explanation was not asked for.

Many candidates got part (d) the wrong way around, saying that the fringes would be more closely spaced and more intense. There seemed to be some guess work evident here. Candidates need to be able to describe the appearance of the single slit pattern and be aware of how it will change for different wavelengths, slit widths and for monochromatic and white light. Some teachers introduce the equation for the single slit although it is not in the specification. This is not necessary but can certainly help the more mathematically minded students. To illustrate the change in the pattern, a simple demonstration can be carried out with a red and a green laser shone through the same slit onto a screen.

A pleasing number of candidates produced very detailed and high quality answers to part (e), with many gaining all three marks. Some drew a graph of intensity, which did not gain a mark on its own.

Question 4

Some candidates forgot to answer the second part of the question and did not make adequate reference to the features of the stationary wave shown. The first part (how a stationary wave is formed) was answered well. Many candidates used the term ‘superimpose’ instead of ‘superpose’ and typically a candidate would lose a mark for this.

Question 5

Part (a) (i) provided a very easy two marks for most candidates. Just a few were unsure about the meaning of ‘kN’.

Part (a) (iii) was generally done very well, with many candidates picking up full marks even if they got the acceleration wrong in the previous question. There was a significant number of students who believed that $t=v/a$ = 150/1.99.

Few candidates gained two marks in part (b) (i). Force arrows should originate from the point where the force acts. The candidate is expected to assume the centre of mass of the LM is roughly central and within the central section of the LM. It is sensible to assume that the thrust will originate either on the outlet or within the central section. For candidates who chose to offset the arrows (by no more than 2 mm) it was assumed that this was to show the examiner where the forces originated. It was sometimes not possible to determine where the candidate’s arrows began. In this case, the candidate was not penalised.

Quite a few candidates could not correctly label the arrows, using terms like ‘upthrust’. Many did not label fully, eg ‘F’ where ‘thrust’ or ‘force from rocket’ would have been better. Some added arrows for velocity and acceleration (especially ‘acceleration due to gravity’ instead of weight). Additional arrows were penalised, as some candidates seemed to believe acceleration is a force.

In part (b) (ii), many candidates did not realise that they had to find 47% of 15100 and almost half found 53% instead; they could only score one mark. A significant number forgot to reduce 15100 altogether.

The majority of candidates selected $v^2 = u^2 + 2as$ and correctly substituted and calculated in part (c). A few did not realise they had to use 1.61 rather than 9.81 for the acceleration due to gravity on the Moon. Some students were unfamiliar with problems where there is an initial velocity and they assumed this to be zero.

Question 6

In part (a) (i), the line of best fit had to start very near to the origin and go between the fifth and sixth points on the graph. Most candidates did this very well. Very few candidates who attempted a freehand line made their line smooth or straight enough to gain the first mark. A smooth curve was expected for the last few points on the graph. Most candidates knew that this is how a spring is likely to behave and assumed a curve would be more appropriate than another straight section.

Many candidates did not get the powers of ten correct or simply ignored them when calculating the gradient in part (a) (ii). There was a general lack of care with the precision of the gradient measurement. Often a line would not go exactly through the origin and this would not be taken into account by the candidate. Gradients were often calculated from less than half of the available length of the line.

Part (b) was done well. However, a surprising number of candidates misread the force as 2.6 or 2.7 or 2.85×10^5 N. Marks were often lost on the unit. The unit (Pa or N m^{-2}) needed to have a capital ‘N’ or ‘P’ and a lowercase ‘m’ or ‘a’.

For part (c), many candidates successfully used Hooke's law to find the extension of a 10 m length of the cable with a force of 150 kN. Many did not realise that they then needed to multiply by 100 to get the extension of a 1000 m section. Some multiplied by 1000 instead of 100. A considerable number thought they needed to divide by 1000. Surprisingly, very few realised they simply could read off the extension from the graph for a 10 m length at 150 kN and then multiply by 100. It was also common to see the Young modulus equation used, but this was unnecessarily complicated and rarely yielded the correct answer. The suspicion is that this question caught many candidates out, because a certain amount of manipulation of numbers was necessary, in addition to substitution into an equation. This is a skill that will be essential for those continuing to A2.

Question 7

There were very few mistakes on part (a). Most candidates correctly showed their answer to more than two significant figures, which was required here. Where one mark was lost it was usually for only giving the answer as 50 rather than 50.15.

For part (c), many candidates wrongly stated that there was no TIR because the angle was below the critical angle. Candidates had to use the term *refractive index* or *optical density*. Use of 'density' by itself was not given credit.

Part (d) was done very well by the majority of candidates. The most common error was to calculate sin = 1.33/1.47 for the glass/water boundary rather than the glass/air.

In part (e), the most common answer was to assume that the ray refracts out of the glass and into the air. Even candidates who correctly calculated the critical angle as 43 degrees did not realise that the ray is one degree beyond the critical angle. Most candidates who correctly showed the ray reflecting did not then show the ray continuing into the water.

Mark Ranges and Award of Grades

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