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Physics 1450

Specification A

PHYA2 Mechanics, Materials and Waves

Report on the Examination

2010 examination - June series

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

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 for the Mechanics materials and Waves unit. There was evidence that many candidates were well prepared. Calculations were laid out in a more neat and methodical manner than in some previous exams. In written responses there was generally a little more awareness of the level of detail required. However, a surprisingly large proportion of students had not learned basic definitions and did not know how to round an answer to an appropriate number of significant figures. This paper was slightly more demanding than the first two PHYA2 papers (January and June 2009) but very similar in demand to the January 2010 paper. 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 on as many exam style questions as possible. There was a fairly even balance between questions requiring written responses and those requiring calculation, with roughly half the marks associated with each, as was the case in January. The most successful candidates were able to perform well on both types of question. In general, the majority of candidate's marks were scored on successful calculations rather than on the questions requiring written responses. Many candidates performed very well on this paper. However the comments below will focus mainly on the common incorrect responses as this will help teachers quickly pinpoint areas for improvement.

Question 1

This question was perhaps easier than the moments question on the January paper, as the context was much simpler. However June 2009's paper featured a calculation of a moment but no use of the principle of moments.

In part (a), candidates were asked to state the Principle of Moments. A relatively small number of candidates managed to gain both marks. We accepted 'clockwise moment**s** equal anticlockwise moment**s** when balanced' as the minimum to gain both marks. If we had insisted on a more strict definition including the phrases 'sum of…' and 'equilibrium', the percentage gaining full marks would have dropped to less than 10%.

It was surprising to find that so many students had not remembered to learn this definition. Improving candidate's recall of definitions such as this is clearly an area that could be worked on by many centres. A large number of candidates gave the definition of a moment instead of the principle of moments and many simply gave a vague description of the topic.

For part (b), quite a few candidates did not read the question and calculated the moment of bike and rider together or they chose the wrong distance. Candidates were often confused about the unit of moment. The most common errors seen were N or Nm^{-1}.

Part (c) was a straight forward moments calculation. It was very similar to a question set in January and the number of candidates scoring zero marks decreased significantly in comparison to the January paper. Those who struggled on this question appeared not to know the difference between a moment and a force. A common incorrect approach was to calculate the 'force' by adding together the two anticlockwise moments.

It was also surprising that only small number of candidates understood that the answer should be stated to two significant figures. Indeed this seems to have been a problem across all of the papers on this specification.

Many students believed that rounding a number reduces the ‘accuracy’, and it is very difficult to shift this belief. However, students need to be persuaded that the lack of precision is in the measurements given in the question, and their final answer should not exceed this precision. The final answer should have the same number of significant figures as the quantity used that has the smallest number of significant figures. It can help if students are encouraged to write down the answer as it appears on their calculators and then give the rounded answer on the answer line.

A common error was to assume that each tyre would experience the same force in part (d). Many candidates who had been unsuccessful on the previous question did pick up this mark for employing the correct method.

The majority of candidates found part (e) very easy and relatively few missed the ‘k’ in kW.

Question 2

In part (a), candidates did not have to have encountered Galileo’s method for investigating freefall to be successful. Many showed awareness that either air resistance would not be a significant factor or that timing would be easier due to the lesser speeds when using an inclined plane.

Considerably less than half candidates were able to resolve to find the component of the weight acting down the slope in part (b)(i). Some used just the mass rather than mg and this response gained zero marks.

Part (b)(ii) was a straight forward use of $a=F/m$ and the majority of candidates gained full marks.

In part (c), many candidates thought the trolley was accelerating at an increasing rate because of the upward curve. Some did not use the term ‘acceleration’ in their answer and some thought that the rate of acceleration was decreasing because the curve was getting straighter. The data plotted on the graph does not support the view that the acceleration decreases. The distance between each pendulum swing increases in such a way to support uniform acceleration.

A very large majority of candidates did not recall that the gradient of a distance time graph gives the speed in part (d). Most of these calculated the average speed using $v=s/t$ with s =3.0 and t = 3.15 × 1.4 rather than the instantaneous speed at 3.0 m.

Question 3

In part (a), the strict definition of amplitude was expected. Candidates needed to say ‘maximum displacement’ and then indicate in some way that this was relative to the equilibrium position. The majority, however, chose to define amplitude as the **distance** between the centre and the peak.

For part (b) (i), the majority of candidates could not give an example of a transverse wave other than electromagnetic waves. Most gave a form of electromagnetic radiation (most commonly ‘light’) or even sound. Common answers that were accepted included ‘water waves’, ‘waves on strings’ or ‘s-waves’.

Most candidates realised that a comparison between the direction of wave travel and the oscillation of the medium was a good way to answer part (b)(ii). It was common, however, for candidates to struggle to express this clearly. The most common error was to say that a transverse wave 'moves' perpendicular to the direction of wave travel rather than 'oscillation is perpendicular to direction of wave travel'.

The vast majority of candidates found part (c) (ii) very straight forward.

The majority of candidates had no problem with part (c) (ii). The exact shape of the line was not important as long as the maximum and minimum intensities appeared in the right place.

There were many very good answers to part (d), such as 'sunglasses/ski goggles reduce glare from light reflected from water/snow' and 'a camera filter reduces unwanted reflections'. Common inadequate responses included saying that polarising sunglasses 'reduce light intensity' because the lenses are 'darker', or that polarising filters reduce UV.

Question 4

For part (a), most candidates found the increase in gravitational potential energy without any problems.

In part (b) (i), half of all candidates realised that the gain in kinetic energy could be calculated from the loss in gravitational potential energy. Many candidates wrote down the equation for kinetic energy and were unable to make progress from there.

A large majority of candidates were able to rearrange the kinetic energy equation in part (b) (ii) and calculated successfully the speed from their answer to part (b) (i).

The direction of the arrow did not cause any problems in part (c). However, the placement of arrow did. The tail of the arrow should originate close to soles of gymnast's feet but the majority placed it to the side, above or below this position.

Part (d) was quite a tricky question, but it was answered well by a large number of candidates using $a=\Delta v/t$ with their value of speed from part (b) (ii).

4(e)
A large number gained four marks or more on part (e) and the Quality of Written Communication was generally very good. The most common reason for not reaching the higher marks was focusing only on transformations and not mentioning the work done by or on the gymnast in order to reach a greater height.

Question 5

It was a little surprising that more candidates did not gain the mark to part (a). A common incorrect answer was *'curve B'*.

In part (b), the majority of candidates did not know that the work done is the area under the line or they did not know a suitable method to estimate area. The most common approach was to treat the curve as a straight line and use $W = \frac{1}{2} F\Delta L$.

The most reliable method in this case is to count the number of large squares, treating all part squares as half a square, and then multiply the total by the value of one square (0.5 J). If this method is taught, the candidates will always get the answer that appears on the mark scheme.

The typical Young modulus of rubber can be found in most data books. This is obtained for small values of strain. The majority of candidates knew what to in part (c) and many gained all three marks. Unfortunately, a significant number of candidates were careless in reading the question and used 0.40 instead of 0.040 and therefore 50 N instead of 10 N.

The majority of candidates were successful in part (d)(i). A common error was to draw another curve or a straight line at a tangent to initial slope of A.

Part (d)(ii) was another definition that caused problems for many candidates. Some failed to gain credit by confusing limit of proportionality with elastic limit. Some neglected to say 'point **beyond** which the load and extension will no longer be proportional'.

Question 6

Many candidates did not seem at all familiar with the use of this diagram in the derivation of the grating equation in part (a) and the placing of the labels was often completely random. A large number did not attempt to label the diagram and half of all candidates did not score any marks. Many who scored one mark had labelled the wavelength correctly but did not accurately indicate the 'line spacing' with a suitable arrow or line.

Most candidates gained the first mark in part (b) for realising that sin θ decreased so θ would decrease. Many candidates failed to gain the second mark by not stating that *d* remained constant. Very few candidates attempted to explain in terms of path difference.

The majority of candidates had no problem matching up the spectral lines in part (c).

In part (d)(i), about half of all candidates were unable to convert lines per mm to line spacing and there was considerable confusion with powers of ten. Many candidates did not convert to metres and many also rounded to one significant figure.

In part (d)(ii) it was expected that the candidate would read an accurate value off the scale. However, many chose a value to the nearest 10 nm, typically 550 nm. In this situation, it is always best to interpolate when reading off the scale. The uncertainty in this reading can then be expressed by giving the final answer to two significant figures. Line P is somewhere between 545 and 548 nm.

Question 7

Part (a) states that reflection occurs. However, half of all candidates were unable to show the ray of light reflecting from the glass-liquid surface. Those who did do this tended to also get the second mark for showing the ray refracting away from the normal line as it entered the air.

In part (b), most were able to use the angles given to successfully calculate the refractive index of glass. Most of these also remembered to give their answer to three significant figures (1.47).

For part (c), candidates needed to realise the incident angle had **just** passed the critical angle and therefore the critical angle would be 63° to two significant figures. Some chose 27° instead of 63°. A common incorrect approach was to use 1.0/1.5 = sin θ_c.

Part (d) was quite a simple question but perhaps, because it was the last question, some candidates may have been short of time. Some may not have realised that they would get full credit for a correct method if they used their answer to part (c).

Mark Ranges and Award of Grades

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