A-LEVEL

PHYSICS A

PHYA2 – Mechanics, Materials and Waves
Report on the Examination

2450
June 2014

Version: 1.0

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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 for the Mechanics materials and Waves unit.

The paper was of a slightly lower demand compared to the summer 2013 paper; a small variation in level of demand from paper to paper is normal. As a result of this, the grade boundaries were slightly higher than in the previous year.

There was the usual mix of written answer and calculation with 40 marks on calculation (more than June 2013), 17 on written explanations and 13 on recall of knowledge. The smaller number of marks for recall of knowledge and the greater number of marks for calculation resulted in higher marks for many candidates. The marks for written explanations remained roughly the same.
A significantly higher number of candidates managed to get over 60 marks out of a maximum of 70. This showed that there are a lot of very good physics students in this year and some excellent teaching. However, we again see many candidates at the lower end who have not gained an understanding above GCSE level in some or all of the topics.

To make the transition from GCSE to AS level, candidates must begin to understand some basic physics principles which they may have encountered at GCSE and only partly understood. The clue that a student is not gaining sufficient understanding is particularly evident on questions where the understanding has to be applied in a context that they may not have seen before. It is still the case that many candidates search the formula sheet for an equation that will 'do the job' rather than thinking through the physics of the situation. This approach may yield some success at GCSE but it is unlikely that a candidate will pass this AS unit unless they gain a deeper understanding. This was particularly evident in question parts: 1(c)(ii), 2(a)(ii), 2(b)(i), 2(b)(ii) and 3(a)(ii). It is particularly evident where candidates use $s=vt$ rather than a 'suvat' equation and *vice versa.*

More candidates seemed to be using good quality black pens as fewer scripts were hard to read on screen. Good quality black gel pens enable a clear scanned image to be produced for the examiners. A sharp HB pencil should be used for diagrams. This allows diagrams to be corrected by the candidate. While pencil diagrams produce good scanned images, passages written in pencil do not and pencil should never be used for written answers.

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

The paper highlighted the need for students to practice simple mathematical principles. In particular, problems with percentages, significant figures and rearranging of equations are highlighted in the analysis below.

Where candidates use equation triangles to help them rearrage equations, more often than not, they recall or write down the triangle incorrectly. This lends weight to the argument that this method should not be used by anyone at AS level. It is a system perhaps suited only to helping students in KS3 and KS4 who are likely to achieve a GCSE Maths grade below a C.

Question 1

(a)(i) The number of mistakes on this question was surprising. Most candidates knew it was something to do with 'cos' or 'sin' but they resolved incorrectly. Common errors included resolving the mass rather than the weight (8300sin25), finding the wrong component (mg cos 25), incorrect trigonometry (mg/sin25) or simply calculating the weight without resolving (8300 x 9.81). Plenty of practice and assessment on resolution of forces on inclined planes is needed for many students.

(b)(i) These presented few problems apart from an occasional power of ten error or use of weight instead of mass.

(b)(ii) As above.

(c)(i) There were lots of really good answers on this question with correct descriptions of energy transformations and mention of friction and 'thermal energy'.

However, some mentioned the appropriate force (friction, drag, etc.) but not the form of energy (internal, 'thermal', 'heat') and vice versa. Some candidates do not know the difference between a form of energy and the process that causes the transformation: 'kinetic energy is converted to friction' being a typical comment.

(c)(ii) This was generally well done, but some used 160m instead of 140m.

Some candidates used a 'suvat' equation but this is incorrect physics due to the fact that the acceleration is not constant. Students must first identify if a situation involves constant velocity, uniform acceleration or changing acceleration. If the acceleration is changing, the kinematics equations used at AS will not be applicable.

Question 2

(a)(i) This was generally well done but a few used t=s/v. Some rounded 0.4946 to 0.495 and then rounded again to 0.50. This was penalised.

(a)(ii) A large majority of candidates used a 'suvat' equation for this. Unusually, quite a few did so correctly with $a=0$ and $u=v=8.5$.

Many teachers encourage the 'suvat' equations to be applied for constant velocity situations and this is fine if the candidates know what to do. Nevertheless, the most common error was the use of 'suvat' with either $a=9.81$ or $u=0$.

For constant velocity situations, it is simply necessary to use, $s=vt$.
Those who did choose $v=s/t$, sometimes rearranged as $s=v/t$.

(b)(i) Uniform deceleration was implied in this question so a 'suvat' approach was appropriate with $s=0.35$m, $u=8.5\text{ms}^{-1}$ and $v=0$. Most errors were due to use of $t=s/v$ or using 9.81 for the acceleration.

A very large number of candidates rounded to 2 dp (0.08). This was forgiven here but it is not good practice. 2sf would be appropriate here (0.082). Many students clearly do not understand the difference between decimal places and significant figures.

(b)(ii) Extensive use of a=9.81 to calculate a horizontal force was seen. Very many candidates clearly did not fully understand the context. They identified a suitable equation but substituted the wrong values. There were many errors such as confusing distance with time, speed with acceleration. Not many used KE/displacement and most of those that tried tended to make errors. Quite a few candidates didn't attempt to answer this question.

Question 3

(a)(i) Most candidates were successful on this one but a few divided by 9.81 rather than multiply.

(a)(ii) There was significant use of mass rather than weight for this moment calculation and 12m was occasionally used rather than 5m.

Incorrect units were often seen. $Nm^{-1}$and NM being the most common errors.

(a)(iii) Most candidates got this one right but a few attempted to use trigonometry to resolve the weight of the ship. A few used a distance of 12-5=7m, perhaps thinking the pivot was at the centre of mass.

(a)(iv) Quite a few candidates did not attempt to resolve T and did 2.5 x T = 8.0xF, but nearly all had a correct moments equation, which was credited.

Question 4

(a) This was the six mark question that included an assessment of quality of written communication. Failure to mention any accuracy points restricted many to 3 marks here. On the procedure, most were detailed. Most extended their answer to explain how the data would be processed to obtain the Young modulus but this did not gain any additional credit.

Few candidates suggested a suitable number of readings.

Many candidates described Searle's apparatus, and this year many of them did it very well, gaining an accuracy mark for doing so.

It is a good idea to encourage students to have a separate section on accuracy at the end of their answer. Students who structured their answer in this way usually gained 5 or 6 marks out of 6.

(b)(ii) This question yielded a high proportion of disappointing answers. For many candidates there seemed to be some confusion over stress and strain. They often labelled the axes the wrong way round, or a Force – extension graph was shown.

Many then got the lines the wrong way round or they didn't label the lines A and B.

Candidates who completely forgot to label the lines did not get any marks for their answer.

Many decided to put a curve at the top of the line for the brittle material and made this curve far too prominent. A material that fractures '*before any permanent deformation takes place'* could only have the tiniest of curves at the top. It is therefore best to encourage students to show a straight line with no curve for a material undergoing brittle fracture.

(c)(i) In this question candidates frequently used a strain of 24% rather than 0.24%. The phrase '*0.24% increase in length*' was clearly not understood by many of the less able candidates.

There were also a rather surprising number of candidates who believed that ΔL was the total extended length rather than the extension, or they did not appreciate the difference between these.

It is often apparent in marking Unit 2 papers that some students have a surprisingly poor understanding of percentages. AS Physics students, perhaps even those also doing AS Maths, may need to refresh their understanding of percentages. Perhaps a few lessons on ' Maths for physics' could be delivered to the whole class at the beginning of the course, followed by a short assessment to verify that students know the basic maths needed for the AS units.

(c)(ii) In this question, failure to find the correct area was quite common. Perhaps seeing the '**A**' near to '1.40' caught out some candidates. Many did not convert millimetres into metres when calculating the cross sectional area.

Question 5

(a)(i) Most candidates produced excellent answers, but there were a few slips, especially with use of 1.33 rather than 1.47.

(a)(ii) Most candidates gained 2 marks here but a few did not use the refractive index of water (1.33) for n_2. It is perhaps the case that some students believe that n_2 is always 1 when calculating the critical angle.

(b) A common mistake seen here was the use of the phrase 'Total internal <u>refraction</u>' rather than 'Total internal reflection'.

It was also extremely common for candidates to say that light would not TIR because it 'hadn't reached the critical angle' for the water-oil boundary. There would be no TIR (and thus no critical angle) because the light is travelling from a lower to a higher refractive index material and under these conditions, the light will refract and there will only be a partial reflection.

(a)(iii) In this question candidates sometimes showed TIR despite having successfully calculated the angle of incidence and the critical angle. Candidates received full credit if their answer was consistent with their previous two answers but this was not seen very often. Of those who chose refraction, some unfortunately had the ray bending towards the normal or even, in a few cases, refracting to the left of the normal line.

Question 6

(a) There were some rather vague answers here such as '*To calculate the wavelength of a light'* or '*to look at the light from stars'*. There needed to be a little more than this to get the mark, i.e. a specific example such as 'analyse the elements present in the atmosphere of a star' or explain that the composition of a material or gas can be determined.

(b)(ii) The candidates who knew this often lacked detail in their answer, e.g. 'it would be dimmer'. Some thought there would only be one colour at **B** rather than a spectrum.

Quite a few thought that the wavelength at **B** would be different from **A** due to the increased angle.

Some candidates thought that the light at **B** would be composed of different wavelengths and the white light at **A** would be a single wavelength.

(c) This was a fairly standard exam question but surprisingly there were few correct answers. Students seemed to be poorly prepared for this question and confusion reigned regarding the meaning of the terms in the grating equation. Use of the *lines per mm* as the line spacing (d =1480) was very common.

There was also confusion between line spacing, d, and order, n. Some used 1480 for d and for n.

Candidates often used 1/1480 and then failed to convert this into metres.

(d) There were a surprising number of candidates who did not attempt this question.
Even if they felt they had the wrong numbers for wavelength and line spacing in 6(c), candidates simply needed to divide their d by their λ, and if greater than 1, conclude that no further orders are possible.

There was also some confusion over the method required, e.g. some used the angle given in 6(c), (51^{o}), and calculated a new wavelength that would give a second order at that angle.

Question 7

(a) The majority of candidates got this mark and only a small number missed out the very important 'per second'.

(b) For 2 marks it was necessary to point out that the particles are oscillating rather than the wave oscillating. For example, some candidates said something like, '*waves oscillate parallel to direction of wave'*, or '*the motion is in the direction of the wave'.*

Confusion between progressive waves and stationary waves was often seen and some candidates talked about 'energy not being transferred with the wave'.

Many candidates talk about 'motion' of particles rather than oscillation. 7(a) and 7(b) highlight the fact that simple descriptions and definitions need to be memorised.

(c) The first part was done well apart from some candidates who did not convert from mm to m. Many rounded to 3sf rather than 2. This was probably because they believed 0.50mm was three significant figures.

(d) This type of question is asking the student to apply their knowledge in a context that may be unfamiliar (assessment objective AO2 – see specification).

A simple explanation describing the formation of a stationary wave was therefore needed here.

However, many students did not spot that the question was about stationary waves. Candidates could mention how nodes and antinodes are formed by superposition, etc.

Mark Ranges and Award of Grades

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

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.

UMS conversion calculator www.aqa.org.uk/umsconversion