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General Certificate of Education (A-level)
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Physics B: Physics in Context PHYB1

(Specification 2455)

Unit 1: Harmony and structure in the universe

Report on the Examination

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GCE Physics, Specification B: Physics in Context, PHYB1, Harmony and Structure in the Universe

General Comments

There was no evidence to suggest that candidates experienced pressure due to time. The paper provided opportunities for all candidates to demonstrate their knowledge and understanding of the specification. Some candidates regularly demonstrated an excellent understanding of key principles, concepts and facts and were able to communicate this understanding with an appropriate use of scientific terminology. Other candidates demonstrated a vague understanding of some of the topic and used language that included some basic scientific terminology.

The mathematical skills demonstrated ranged from highly skilled candidates who confidently dealt with structured calculations to candidates who had problems rearranging basic formulae. Candidates need to be encouraged to develop a more rigorous approach to presenting calculations where the working out is well structured and uses a set procedure: summary of data given in question (include units), statement of quantity to be determined, statement of formula to be used, substitution into formula, rearrangement of terms in formula, statement of answer with unit and appropriate number of significant numbers.

Examples of areas where candidates achieving lower grades showed their lack of mathematical knowledge included being unclear about how to rearrange formulae particularly those formulae involving powers and roots, identifying prefixes and substituting with correct powers of ten, substituting data into formulae incorrectly by mixing up terms, dealing with indices and rounding of data mid-calculation instead of carrying forward number in calculator.

In general, candidates would improve their performance by being more prepared for the paper; spending more time acquiring the knowledge and practising the application of this knowledge.

Question 1

Most candidates were able to answer part (a), with most common answers being proton/neutron. Fewer candidates correctly answered part (b); here common errors included 3 quark combinations and combinations of quark-antiquarks that included the strange quark.

Question 2

Surprisingly, few candidates achieved full marks in part (a). The most common error was to include the (electron) antineutrino instead of the (electron) neutrino.

Part (b) was poorly answered; many candidates had no idea of the exchange particle involved in β^+ decay. Common errors included gluon, neutron, pion and weak force.

Question3

The majority of candidates were successful in part (a), where errors occurred these involved mixing up of the c and c_s terms in the formula.

Part (b)(i) presented more problems to candidates, with many candidates not converting from kilometres to metres. There were many candidates who found the time taken for Ray A and the time taken for Ray B, then subtracted these to find the time difference but many candidates rounded the time values before subtracting.

There were some excellent answers to part (b)(ii) but these were in the minority. Many candidates found it difficult to describe graded-index and often described step-index or monomode instead.

Question 4

Part (a) was answered well with most of the candidates knowing the positions of the Sun, Main Sequence and O-class stars. Also, part (b) was well answered.

Question 5

Most of the candidates were able to achieve at least two marks in part (a). The most common mistake made was to give the answer to an inappropriate number of significant figures. Here the sound intensity was quoted to two significant figures therefore the answer should have been given to two significant figures. Other common errors were: dividing the distance by two before it was substituted into the formula, incorrect rearrangement of the terms in the formula and using the incorrect formula $I = \frac{P}{\pi r^2}$ instead of $I = \frac{P}{4\pi r^2}$.

Part (b)(i) proved to be challenging with very few candidates achieving full marks. However, most of the candidates were able to determine the intensity ratio. Worryingly, a significant number of candidates thought that $\frac{10^{-12}}{10^{-6}} = 2$. Very few candidates knew that intensity $\propto$ amplitude^2 and even fewer were able to apply this to determine the final answer.

Most of the candidates gained credit for their answer to part (b)(ii). A significant number of candidates did not answer the question and instead repeated the information regarding sensitivity to loudness or described aspects of the physical environment that may have affected the father's hearing.

Question 6

This question was poorly answered.

In part (a) few candidates were able to correctly state the name of the process. Many thought that the process was the photoelectric effect or annihilation. Over 16% of candidates did not attempt this part of the question.

In part (b)(i), few candidates were able to gain the mark. A common wrong answer was to merely restate the information given in the question: energy is needed to create an electron-positron pair. Another common incorrect answer was that energy was required to overcome repulsive forces. Over 10% of candidates did not attempt this part of the question.

Part (b)(ii) had a higher success rate with more candidates able to give a credit worthy statement but good responses were still in the minority.

Part (c) was the answered well.

Question 7

Part (a) was well answered by a few candidates; many were able to describe the general conditions for creating a stationary wave but without being specific about how these conditions arose in the case of a stretched string.

In part (b)(i), most of the candidates were able to achieve at least one mark. Some candidates drew diagrams which were not accurate enough in terms of their general shape and the locations of the antinodes and node. Candidates should be encouraged to ensure that diagrams of this nature should be accurately drawn.

In part (b)(ii), most candidates were able to produce a credit worthy responses but these were often low level statements. Very few were able to produce a response worthy of both marks. The quality of language used often lacked the precision required to effectively communicate the required information. Many candidates talked about the wavelength changing from ½ λ to ¼ λ thinking that the wavelength had decreased and therefore the frequency had doubled. Few were able to describe that the length of pipe now contained ¼ λ instead of the original ½ λ. Many candidates confused fundamental frequency with wavelength by describing the fundamental frequency as being ½λ or ¼ λ.

A significant amount of candidates achieved all three marks in part (c). Others experienced difficulty in rearranging the formula and dealing with the root sign. A few candidates had problems dealing with $\frac{1}{2L}$ by incorrectly treating it as $\frac{1}{2} \times L$.

Question 8

A significant proportion of candidates achieved no marks in part (a)(i), use of *E*= *hf* was common among this group. Another common error seen was an attempted use $c = f\lambda$ and $\lambda = \frac{h}{mv}$. Candidates, who recognised that they needed to determine the gradient of the graph and were able to read data from the graph with a fair degree of precision, produced an answer inside the range on the mark scheme and accessed all three marks. Unfortunately, many candidates ignored the powers of ten of the quantities in the graph and so lost valuable marks.

On the whole part (a)(ii) was answered well, with most of the candidates obtaining all three marks. Most of these candidates used $hf = \varphi + \frac{1}{2} mv^2$ in preference to $hf_0 = \varphi$. A common mistake was incorrect rearrangement of the terms in $hf = \varphi + \frac{1}{2} mv^2$. Over 10% of candidates did not attempt this part of the question.

Part (b) was answered well by higher scoring candidates; who addressed the minimum frequency aspect of the question. Candidates who scored fewer marks often attempted to describe the photoelectric experiment without giving any explanation of the effect or they were only able to describe the photon nature of light or work function of the surface.

Question 9

Very few candidates were able to explain luminosity. Many described it as brightness or intensity or power per square metre.

Part (b) again proved to be extremely challenging for all but the best prepared candidates. There were two main aspects of this question that many candidates did not appreciate. Firstly, many candidates were unaware of the link between apparent magnitude and brightness. Secondly, candidates did not appreciate that brightness was affected by power output and distance away from the observer. This meant that a significant proportion of candidates achieved no marks in this part.

Most of the candidates obtained at least two marks in part (c)(i) indicating that they were familiar with the Doppler Effect. Only a few candidates made an attempt to describe the stretching/compression of the space between the wave fronts. A significant number of candidates attributed the change in wavelength to the position of the source rather than the source's movement relative to the observer.

The calculation in part (c)(ii) was done well, with most of the candidates obtaining at least two marks. Only a few candidates, those who realised that the change in wavelength was 0.2 nm, were able to obtain all three marks. Again, a significant number of candidates made no attempt at this calculation.

Question 10

Very few candidates performed well in part (a). Most ignored the path difference aspect of the question and limited their responses to general statements about constructive and destructive interference and the production of bright and dark fringes. Of those candidates who did attempt an explanation in terms of path difference many confused the term path difference with phase difference. Very few candidates used the diagram to identify the path difference.

Many candidates had partial success with part (b) with a significant number achieving at least two marks. Few candidates realised that θ = 0.85π. A common approach was to suppress the *n* term in $n\lambda = d \sin\theta$. Candidates did not seem able to connect the information given above **Figure 6** with the calculation. A common physics error was the attempted use of $\sin\theta = \frac{\lambda}{a}$. Other errors that occurred frequently were the incorrect rearrangement of terms in the formula and having the calculator in radians mode instead of degrees.

Part (c) was answered well, with many candidates able to describe the difference between the spirals on DVDs and CDs. Fewer were able to gain credit for their explanation of why these differences required a higher precision tracking system.

Part (d)(i) was again answered well, with many candidates producing a good description of a compression technique. Common errors here included descriptions of TDM and sampling.

The answers to part (d)(ii) were of a good standard, with most of the candidates achieving at least one mark. However, the language used by most of the candidates was imprecise and lacked detail.

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