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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

Most of the paper seemed accessible to students. It is possible to detect an increasing familiarity with some parts of the specification. It was particularly pleasing to see the QWC question (question 10) answered so thoroughly. Some concepts relating to communications technology still seem to be unfamiliar to a significant number of students. Modern physics seemed to represent a challenge with parts of questions 6 and 12 being poorly answered.

Students should be advised to improve the clarity of their work. Use of technical vocabulary still challenges many students. However, it is in their mathematical work that lack of clarity is most conspicuous. Poor setting out leads to more errors and, subsequently, leads to a failure to attract compensatory marks. Students should be advised to start their calculations with a clearly stated equation, including the subject and an equation sign. Often, the quoting of, for example a ratio seems to indicate that the student is thinking along the correct lines but it is insufficient to attract any marks.

Question 1

This question was answered well by many students. Some students lost marks through the use of incorrect technical vocabulary. For example, some referred to the luminosity of a star when observed from the Earth.

Question 2

The abscissa was usually labelled correctly but, when labelling the ordinate, many students forgot that it was *relative* intensity or they included a unit on the label. Part (b) was answered correctly by nearly all of the students.

Question 3

In part (a), nearly all students could express refractive index as a ratio of the speeds of light in the different media. A common mistake was to have the ratio the wrong way round. Significant figures were usually dealt with appropriately. This was a question in which many students lost compensatory marks because they failed to express mathematical work clearly. For example, in order to gain the first mark, it was insufficient merely to mention the ratio of speeds: it was necessary to equate this to the refractive index.

In part (b), only about a third of the students gave an answer in the appropriate range.

Question 4

The majority of students gained some credit to their answers to this question but clear and complete answers were surprisingly rare for such a standard explanation. Students were expected to refer to the different features of longitudinal and transverse waves and to the restriction of the planes of oscillation in polarised waves. Quite a few students lost marks because of their lack of clarity. Statements such as “the wave oscillates in its own direction” were not deemed to be creditworthy.

Question 5

Most students did well with this question. A few did not identify the electron-antineutrino sufficiently clearly. Some gave a positron instead of a beta particle. A few attempted to give equations in terms of quarks and a few others simply made wild guesses as to the natures of the particles involved.

Question 6

The answer to part (a) was not well known. Students had been expected to refer to a pair of gamma rays although credit was given simply for the mention of gamma rays. Simply stating that energy was emitted was insufficient. Reference to Z_0 particles was permitted. Part (b) (i) was also poorly

answered. Students were simply expected to state that mass could be converted into energy and vice versa.

Part (b) (ii) was well answered. Most students identified the three correct conservations. However, students should be advised that, when asked for three responses, they should not give more than three.

Question 7

In part (a) (i), many students calculated the power correctly but then went on to use an inappropriate equation for the intensity. They tended to use $4\pi r^2$ for the surface area of a sphere, rather than πr^2 for the area of the drum. In part (ii), many students realised that they had to use the correct equation for intensity but they often used incorrect data. Only a minority remembered that a reduction of 3 dB has the effect of halving the intensity in part (iii).

In part (b), students tended to realise the importance of reflection although many omitted to mention any item from which reflections might occur. The significance of absorption tended to be forgotten. A few students made sensible references to the fact that the inverse square law applies only to point sources.

Question 8

In part (a) (i), most students remembered the relationship between frequency and periodic time but many omitted the factor of two and others made errors in their powers of ten. Few students realised that part (ii) was concerned with the required quality of sound.

Many students gave quite good answers to part (b). Some got the argument the wrong way round, suggesting that low pass filters removed low frequency sound. Few students gave convincing explanations of the purpose of the filters. The overwhelming majority of students gained some credit for their answers to part (c) but some failed to explain what modulation meant and others made no reference to a carrier wave.

Only a minority of students seemed clear on the advantages and disadvantages of this frequency range. Answers about signal range, noise or the obstruction of signals seemed to be randomly assigned to advantages or disadvantages.

Question 9

Most students made some progress in part (a). Common errors were in powers of ten, factors of 2 in the choice of angle and in the calculation of d. Once again, some students who were working along correct lines failed to gain compensatory marks because of lack of clarity with their mathematical work. Jumbles of numbers are unlikely to attract marks in the absence of correctly stated equations.

In part (b), the majority of students gained some credit for their explanations of how information was read from a disc although only a few responses were clear enough to attract full marks. Students should be advised that clarity about path difference, phase difference and constructive/destructive interference is important. Some students were unclear that the path difference occurred at the transition between the land and the bump. A sizable minority of students had no idea about the role of interference in this process. Some were content with very general statements that the lands and bumps signified the 1s and 0s of the binary system.

Question 10

This question was well answered. It was pleasing to see well structured responses showing a clear and detailed understanding of the classification of these particles. Even weaker students demonstrated some useful knowledge of the topic.

Question 11

A disappointing number of students failed to gain any marks for part (a) although the majority were at least partially successful. The successful students often lost a mark through being unclear about the

continuous nature of the absorption of wave energy or the way in which this might be expected to accumulate according to wave theory. Some also omitted specific reference to the work function.

In part (b) (i) some students did not make it clear that, under these conditions, photoelectrons would not be produced. In part (b) (ii), the plotting of points was usually accurate but the drawing of best fit lines was poor. Some were drawn without a ruler; others were very short or at an unusual choice of position or gradient. Poor choices of line were penalised in this part but not thereafter. Most students got the marks for reading correctly from the abscissa but quite a few failed to reads the power of ten shown on the axis. Careful reading of questions, data and graphs should be recommended to students.

In (b) (iv), the majority of students plotted the additional point correctly and attempted to draw a line parallel to their original but many were not sufficiently careful. In the final part, many students had a problem in that they did not extend their original line as far as the intercept. Some followed a calculation route, using their value of threshold frequency. This was permissible but most of those who chose this route found themselves confused as to the unit, writing a numerical answer that should have been in J on an answer line that quoted the unit as eV.

Question 12

Strictly correct answers to part (a) were rare but credit was given to answers involving charged objects rather than parallel plates. Those who chose to use magnets, almost universally mentioned positive and negative poles of magnets! This was penalised.

Although there were some good answers to part (b) referring to the diffraction pattern and top the wave-particle duality, some interpreted the diagram as representing the energy levels in an atom.

In part (c) (i), the correct equation was generally used but students often did not use the correct substitution for wavelength. The unit for momentum was often correct. A disappointing number chose to give a version of the unit derived from the equation instead of an appropriate, remembered unit. A significant minority of students did not attempt (c) (ii). Most had no idea of how to find the kinetic energy from the momentum.

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