Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH12) Paper 01 Waves and Electricity

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Introduction

Q11 This was well answered by the majority of candidates as most understood that electron diffraction demonstrates the wave behaviour of electrons. However, some candidates made statements to the effect that electrons were waves and we did not award the first marking point in those cases. A few candidates recognised that the electrons were displaying wave behaviour but failed to identify that either diffraction or interference were taking place.

Q12 This was well understood by the majority of candidates. For the first marking point we wanted candidates to tell us that the current in each wire was the same but we accepted constant as an alternative. For the second marking point we really wanted reference to cross-sectional area but very few candidates were stating this and we accepted area instead. For the third marking point we wanted reference to the equation $I = nqvA$ as well as recognising that the drift velocity in copper was less. Some candidates focussed their response entirely on charge carrier density and neglected to refer to the other variables in the equation. It is important to note that we wanted candidates to refer to the names of the variable, for example we wanted to see current and not just I.

Q13(a) This is a standard question and there was some improvement in the quality of responses compared to previous series. However, we need to see the word direction in relation to energy transfer or propagation of the wave and not to the oscillation or vibration. Som responses contained no reference to vibration or oscillation and score zero as a consequence.

Q13(b) Candidates were provided with a detailed diagram from which it should have been obvious that there was a path difference. Any reference to path difference achieved the first marking point provided that candidates did not then state that the path difference was zero. For the second marking point we did not accept path difference = $n\lambda$ alone as we wanted to be told that n was an integer. Unfortunately, the majority of candidates failed to do this. For the third marking point it was enough to state that the waves were in phase but those candidates who wrote phase difference = $2\pi n$ we wanted to be told that n was an integer or the mark was not awarded. Some candidates referred to constant phase difference or phase relationship and this was not given credit.

Q14(a) This was an extremely poorly attempted question in which many responses scored zero. It was evident from the quality of the responses that many candidates had not carried out this practical or one similar. The correct answer to this question is shown in the mark scheme for this paper in which there is a potential divider circuit. The majority of candidates attempted to put a variable resistor in series with the LED and, although this would not produce the graph shown, we accepted this for the second marking point. The first marking point required a circuit with a power supply, LED and

ammeter in series. Surprisingly a large number of candidates could not draw the correct symbol for a LED or a diode. This meant that neither the first nor the third marking point could be awarded. It was also noted that the quThis presented little difficult to the majority of candidates. Ideally, we wanted 37m

Q15(b) Candidates were provided with quite a lot of information in the stem of this question and there was a clue that volume was a relevant quantity to consider here. Unfortunately, many responses were simply a repetition of information that had been provided and thus were not worthy of credit. Candidates were told that a graph of resistance vs I^2 would be a straight line and many simply repeated this instead of referring to resistance being proportional to I^2. Had candidates recognised that volume was area time length then most would have scored the first two marking point but this was not seen in the majority of responses.

Q16(a) The majority client to protect the eye from a laser. Responses to this question once again demonstrated a lack of practical work.

Q16(b) Most candidates scored the second marking point but the first was much less common as we were looking for reference to maxima and this was usually missing.

Q16(c)(i) Most candidates scored the first marking point but many used 18^0 which meant that only the second and third marking points could be scored. For the second marking point we accepted any number divided by 250 but here many candidates did not use the correct power of ten and could not score the fourth marking point as a result. For the fourth marking point candidates were required to convert their answer to nm but many left it in m and this was not considered good enough. The third marking point was often awarded but a number of candidates confused n with d and could at most score the first marking point.

Q16(c)(ii) Many candidates scored both marks by recognising that the maximum diffraction angle was 90^0. Some candidates used 89^0 and lost both marks.

Q17(a) Usually the correct answer was seen however, candidates who rounded their answer to 2.25×10^8 ms^{-1} were not awarded the second marking point. Again, some answers lacked a unit and were not awarded the second marking point.

Q17(b) For the first indicative content mark we wanted to see reference to increased (optical) density in water, lower speed in water or greater refractive index in water and this could have been stated with reference to any of the three rays. This mark was frequently awarded. Many candidates referred to bending of light rather than refraction of light and did not score the second indicative content mark. The third and fourth indicative content marks were commonly seen but some responses simply stated reflection rather than total internal reflection and gain no credit for the fourth indicative content mark. The fifth and sixth indicative content marks were often seen but again some responses referred to bending rather than refraction.

Q18(a) Very few candidates scored full marks in this question which was a little surprising as it is a question that has been asked frequently in the past, albeit in different contexts. Some candidates tried to answer this question in a generic fashion but it was necessary to use the context provided. For the first marking point it was necessary to indicate that the wave was being reflected but it had to be made clear from what the wave was reflecting. For the second marking point we wanted to see the idea of interference or superposition but often candidates failed to mention either of these and were limited to scoring the first marking point only. Some candidates made statements such as the wave bounced or waves overlapped and these were no given credit. For the third marking point it was necessary to link and antinode with constructive interference or a node with destructive interference but less than ten percent of candidates were awarded this mark.

Q18(b) In this question candidates were provided with a labelled diagram of a standing wave and were asked to describe the motion of two points. It was evident from the responses that the difference between displacement and amplitude was not well understood. The first marking point referred to point X having maximum amplitude not maximum displacement because this was covered in the second marking point. It should have been evident that at point Y there was zero displacement from the equilibrium position and we di not accept responses that said zero amplitude. A large percentage of candidates scored zero for this question and the majority of those who scored anything did so for the third marking point.

Q18(c)(ii) This question presented little difficulty to the majority of candidates but it is important to note that as this was a show that the answer of 24 was not awarded the second marking point due to having too few significant figures.

18(c)(ii) Surprisingly, around a third of candidates scored zero marks for this question which involved a calculation based of the velocity of a wave on a vibrating cable. Although the context was different, this type of question has been asked frequently in the past. The majority of candidates however, scored mainly from the first three marking points. The first marking point required that candidates calculate the tension in the cable as the mass had been provided. Unfortunately, many candidates failed to do this. As a consequence, the second marking point could not be awarded, and as a tension had not been calculated the third marking point could not be awarded either. Many candidates simply substituted a mass into the equation which is incorrect. The fourth marking point required the use of the wave equation with a specific value for either wavelength or frequency and the majority of candidates failed to recognise that the wave with the lowest frequency was the one in which the wavelength was twice the length of the cable. The consequence of using the wrong value for the fourth marking point meant that the fifth and sixth marking points could not be awarded either.

Q19(a) Almost three quarters of candidates failed to score anything in this question. For the first marking point it was necessary to indicated that an electron or an atom absorbed a photon or that a photon collided with an atom or electron. Often the word photon was missing from responses with many candidates simply referring to light. Many responses jut referred to a photon colliding with the metal surface rather than with an atom or electron. For the second marking point it an explanation of the photon providing energy to the electron resulting it is emission but this was not often mentioned. Some candidates indicated that electrons provide energy to photons and clearly achieved no marks.

Q19(b) The first marking point was usually seen as it was enough to make a correct reference to threshold frequency or work function. We did not insist upon seeing the word photon in this case as it had been necessary to see this in Q19(a). The second marking point was awarded less often as many candidates failed to link the photon energy to its frequency.

Q19(c) In this question candidates were provided with a frequency range and the work function of a metal and were asked to deduce whether or not the photomultiplier could detect light within the given range. There were a number of ways to make the comparison necessary for the fourth marking point but none of these would have been possible if a correct calculation had not been made. For the first marking point it was necessary tot convert the work function energy into Joules and substitute this into the photon energy equation to calculate a frequency which could then be used in the wave equation to provide a wavelength. As the wavelength was larger than the longest wavelength of the range provided it should have been evident that all wavelengths could have been detected by the photomultiplier. Some candidates tried to answer this question by using the full Einstein equation for the photoelectric effect and as a consequence provided some very confused responses.

Q19(d) The majority of candidates scored only one mark for this question. The initial velocity of the electron was provided and from this the initial kinetic energy of the electron could be calculated for the first marking point. Candidates were told that the kinetic energy then increased which meant that the electron was being given more energy by acceleration across the potential difference. The energy needed to be calculated by multiplying the potential difference by electron charge for the second marking point. Adding these two energies together lead to marking point three. Some candidates multiplied electron charge by the work function value given in the previous part which was clearly incorrect. A few candidates calculated both energies but incorrectly subtracted one from the other.

Q19e This question showed a potential divider circuit with a power supply which had an internal resistance. For the first marking point it was necessary to calculate the correct current through the circuit. This could have been dome by using the pd and

resistance of one of the resistors or by adding the resistances and using the total pd of 432V. Many candidates were unable to do this correctly as there was often confusion about the correct amount of potential difference to use. As a consequence, many candidates failed to score the second marking point which was simply awarded for multiplying 108V by 4. The third marking point was awarded for any calculated value of potential difference or resistance using values from the question but the fourth marking point could only be scored if the correct values were used.

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