Pearson Edexcel

# Examiners' Report
# Principal Examiner Feedback

## January 2021

Pearson Edexcel International Advance Subsidiary Level
In Physics (WPH12)
Paper 01 Waves and Electricity

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**Introduction**
This unit assessed student understandings of the topics of Waves and Electricity (specification points 33 to 80). Section A had 10 multiple choice questions, whilst section B contained a mixture of short and long answer questions, calculations, and one 6 mark linkage question.

As with all A level courses, this paper assessed both the ability of students to understand the content, and their ability to apply this understanding to a number of different applications.

This section of the specification contains core practicals 4 to 8. These were practicals that students were expected to have undertaken themselves, and questions about these practicals can be asked within the papers. Question 18b was centred around Core Practical 6, and Question 19 was centred around Core Practical 7.

**Section A – Multiple Choice**

On average, students scored between 6 marks out of 10 on this section. Question 4 was the most successfully answered, although two of the questions were correctly answered by less than half of the students. In particular, Question 1 was answered correctly by only a quarter of the students, possibly as the word “base” in the question had been missed when reading. Typical incorrect answers were usually C or D, both of which are used as units in equations involving power, but are not part of the base units for power.

**Section B**

**Q11**

Although almost half of the students scored both marks on this question, there were a significant number who either did not use the correct formula to calculate cross-sectional area, or failed to insert a correct value for the charge of an electron. Most were clearly aware of the formula that they should use, but many failed to recognise that, as the radius value had been given, they only needed to do a $\pi r^2$ calculation to work out the cross-sectional area. Some assumed that the value given was a diameter, so halved it before substituting into the equation, whilst others forgot to include π or to square the r value. Those who were not clear about the value to insert for *q* either ignored substituting anything in for it or, occasionally, used the mass of the electron instead.

**Q12**

Due to the nature of the question (and the mark scheme) the majority of students scored 0, 2 or 4 marks on this question. A number of students were not able to recognise the correct type of superposition, so got them the wrong way round. The mark scheme allowed such students to achieve a maximum of two marks if they could correctly identify the characteristic phase difference or path difference to match up with the type of superposition. It is worth reinforcing that the correct phase difference description for destructive superposition is not “out of phase” but has to be “antiphase”.

A number of students used stationary wave terminology, such as nodes and antinodes, which were not relevant to this question, as it did not represent a stationary wave.

**Q13 (a)**

Around half of the students scored both marks on this question. There were a couple of ways that this question could be answered. The most common method was to attempt a $V=IR$ calculation to work out the current in the circuit. Unfortunately, a number of students used the wrong value of $V$ in this equation, so ended up with an incorrect answer. The same sort of mistakes were made with the alternative potential divider equation, with incorrect values of V (in both versions of the mark scheme) leading to common incorrect answers of 1033 Ω (where 1.50 V had been used as the p.d. across the fixed resistor) or 3967 Ω (where 1.19V had been used as the p.d. across the LDR). Another common incorect answer was 6303 Ω, a figure obtained when the student had worked out the whole circuit current and had not been aware that they needed to subtract the resistance of the fixed resistor to get the resistance of the LDR.

A small number of students read the instruction about negligible internal resistance and decided to use the e.m.f. equation, which usually resulted in no marks being awarded.

**Q13 (b)**

The majority of students failed to score any marks on this question, with the majority of these describing internal resistance or just general properties to do with LDRs. Unfortunately, as the information given in part (b) (along with the calculation completed in part (a)) made it clear that in brighter light, the resistance was less, there was no possibility of general statements about resistance changes with light intensity any credit. The better students tended to do calculations to show either than the p.d. across the resistor would be so high, or the p.d. across the LDR would be so low, that a resolution of 0.01V would not be able to record the difference between these values and 1.50V (for the fixed resistor) and 0.00V (for the LDR).

**Q14**

This question was generally answered quite poorly, with only a handful of students scoring 4 marks, and the most commonly-awarded mark being 0. The majority of past paper questions on energy levels in atoms tend to focus on the effect of electrons within the atoms dropping energy levels and releasing photons as a result. The majority of students appeared to be answering the question as if it was asking the same thing again, so for many the only mention of photons was in terms of them being released when electrons dropped back down levels.

Clearly there were a number of students who were confused by the fact that external electons can give energy to electrons in atoms, so most focussed on discussing what happens when photons interact with atoms. Even then, the majority of students who scored 0 marks discussed the possibility that the photons did not have enough energy to meet the work function, showing that they thought the question was about the photoelectric effect. Although it was clearly stated in the question that both the electron and the photon had the same energy (12.3eV), many chose to answer it in terms of the electron having enough energy to move electrons in the atom up energy levels, whereas the photons did not.

**Q15 (a)**

A standard definition that was answered reasonably well. The most common error was to describe light as bending rather than changing direction. The reason for the change of direction was much more commonly stated clearly.

**Q15 (b)**

Although just over a third of all students achieved 3 marks on this question, almost a third scored 0, so it was clearly a question that distinguished students quite readily. The main hurdle was the some students were not aware of the correct trigonometry required to calculate the angles, with some using sin or cos functions when they should have been using tan. A surprising number of students only correctly calculated one of the two angles, and those who were used to different scenarios often thought that the light was travelling from the air into the water, rather than the other way round. For some this resulted in their answer being the reciprocal of the correct value.

**Q16**

This style of question is often quite difficult for students to access, so it was quite pleasing to see that there was quite a reasonable spread of students scoring all of the different possible marks here. The general statements for indicative content points 1 and 4 were most commonly awarded, although the other indicative content points were all seen on a regular basis. A small minority managed to answer the question without ever stating which of the components they were describing. This was accepted for indicative content points 2 and 3, as these referred to aspects that were observed in both components. However, it is important to make it clear which component is being discussed when being asked to compare.

Several students referred to the gradient of these graphs being $1/R$, which is not the case. Also, a significant number were incorrect or too vague about some of the points (e.g. not describing which particles were vibrating more).

**Q17 (a)**

This question was generally well answered, with more than half of the students scoring 3 marks or more. This type of calculation has appeared on previous examination papers, although usually just to calculate the kinetic energy, rather than the speed of the released electrons. As such, the main stumbling point late on the calculation tended to be the inability to determine which value of mass to insert into the equation for kinetic energy. For some students, there was a mismatch in terms of the units used in the photoelectric effect equation. There were a number who used a photon energy in Joules with a work function in eV in the same equation.

**Q17 (b)**

This was a demanding question as students had to consider two different factors which both had a differing effect on the photoelectric effect. Weaker answers tended to focus on the fact that as the two properties both increased, the speed must also increase. However, a number of students identified that as the intensity only affected the number of electrons released, it would have no effect on the kinetic energy or speed of the released electrons. There were also some good descriptions of how the increased wavelength would reduce the photon energy but some jumped straight from higher wavelength to lower kinetic energy of electrons, so they had not linked their argument very well.

A small number of students used the idea of decreased photon energy or frequency to argue that electrons would not be released at all (as the energy was below the work function or the frequency was below the threshold frequency). This was not accepted as the question was clearly about the effect on electrons that were being released.

**Q18 (a)**

Just over half of the students scored 0 on this question, partly due to a lack of clarity in the terminology used. This question was expecting a description of what would be done in an experiment, but many answered it as if it were a description of what happens when you place a polarising filter so that its plane of polarisation is at right angles to the plane of polarisation of the light.

Marking point 1 was often not achieved due to the lack of mention of "polarising" as "filter" on its own was not accepted. Marking point 2 was often not achieved due to a lack of description about the need for the polarising filter to be rotated before observing the intensity decreasing.

In the past when such questions have been asked on this paper (or the previous WPH02 paper) there have been a lot of students who have answered such questions with a description using two polarising filters. It is pleasing to see that there were very few such descriptions on this occasion, with most mentioning just a single (polarising) filter.

**Q18 (b) (i)**

A really disappointing set of answers for this question, considering that the equation is directly taken from one of the Core Practical tasks. In the June 2019 paper for this unit, a question had been asked for students to determine the number of lines per mm on a diffraction grating, and a significant proportion of the students had actually worked out "d" from the equation and had clearly thought that this was the number of lines per mm. The question on the current paper shows that a number of students still think that this is the case, as this was the most common incorrect answer.

Other incorrect answers were centred around the measurement of grating to screen and of central maximum to first order maximum. The former was perhaps related to the fact that a number of students went on to do the following part of the question by using Young's double slit formula, where "D" is the distance from the double slit to the screen.

Some answers which were close did not make it clear enough that it was the slit spacing, by using phrases such as "the distance between the diffraction gratings". A significant number also stated that d was simply "distance" without stating which distance it was.

**Q18 (b) (ii)**

Most students achieved marking point 1 on this question, but for a significant number of these, they failed to achieve any further marks as they did not know what the letters in the equation $n\lambda = d\sin\theta$ stood for. Many thought that the answer they were searching for (number of lines per mm) was represented by the letter "n" in the equation, with most of these using the grating to screen distance as "d". A number of students who substituted values correctly clearly thought that "d" was the number of lines per mm as they did not invert the value and quoted it as their answer.

**Q18 (b) (iii)**

This question was poorly answered, with a lot of incorrect physics being quoted as part of the answer. Even those who described moving the diffraction grating away from the screen had suggested it as they felt this would result in the value of $\theta$ becoming greater, which was not the case. Just as many suggested moving the diffraction grating closer to the screen, whilst a number suggested changing the distance between the laser pointer and the screen.

Some reasonably good arguments were close to the idea of marking point 1, but suggestions of measuring to the second order maxima (which would normally be a good suggestion for this practical) could not be accepted as the question had clearly stated that only the first order maxima could be observed.

Likewise, as the question had suggested for students to explain how the value for lines per mm of this diffraction could be improved, any suggestion of choosing a different diffraction grating could not be accepted.

**Q19 (a)**

Students did not perform quite as well as expected on this question, as it is a fairly standard circuit commonly used at GCSE level. The main reasons for students losing a mark or both were: drawing the wrong symbol for the variable resistor, failing to include a power supply in the circuit, and drawing the voltmeter in the wrong place in the circuit. Other than that, there were some good circuits, and some used potential divider symbols which were accepted as long as the circuit was viable.

**Q19 (b) (i)**

Due to the fact that the graph provided was a perfect straight line through the origin, it was not necessary to calculate a gradient for the graph, as long as a significantly high p.d. value was chosen. Although students did generally well on this question (almost two thirds scored 3 or 4 marks), the main issue was the apparent expectation that this practical is usually depicted as a graph of resistance against length. The fact that this graph was showing p.d. against length was ignored by some students who just did the calculations as if the p.d. value was a resistance. These students did not tend to score very well.

For those who understood clearly what the graph was showing, the only other mistakes made were in confusing resistance and resistivity in the equation, and having the wrong units for resistivity at the end.

**Q19 (b) (ii)**

This was a relatively simple question, as long as students were aware that they just needed to read off the p.d. for the given length and to use it in a suitable power equation. Other students who eventually ended up with the correct answer used much more elaborate methods in order to do so. Some took their value for resistivity from (b)(i) and used it in the resistivity calculation to determine a value for *V* or *R* to use in an alternative power equation. By one method or another, almost two thirds of the students scored all 3 marks here.

**Q20 (a)**

This question was not answered very well, largely due to the inability of most students to recognise that the area that had to be subsituted into the equation was meant to be the surface area of a sphere (as radiation spreads equally in all directions). It is worth reminding centres that Appendix 6 of the specificaton outlines the mathematical requirements of students and section C4.3 lists the different areas and volumes that are required. This includes the surface area of a sphere. Many students on this examination used the area of a circle, whilst those who scored 0 generally used the given value of distance as an area in the equation.

A small number of students who calculated an area using $\pi r^2$ ended up getting an intensity value of 5.1 $Wm^{-2}$ and comparing this with the given value of 4.5 $Wm^{-2}$. It must be remembered that there is no error carried forward within a question, so students using this method could not achieve marking point 3.

Some candidates determined the area that the radiation would spread out to before the intensity became low enough. Unfortunately, many of these students then went on to compare their calculated area of 0.22$m^2$ with the given distance of 0.25m to come to a conclusion, which does not consider converting the surface area into a radius value.

**Q20 (b)**

This was a relatively straightforward calculation, with more than half of the students scoring all 3 marks here. The main mistakes came in terms of some students failing to recognise the power of 10 associated with a prefix “M” on the frequency value given. Most of these used milli instead of mega. A large number of those who scored just one mark failed to recognise that a simple *E=hf* calculation did not directly lead to an answer in eV, so gave their value in Joules as an answer in eV. It should be remembered that single-step calculations are unlikely to be allocated more than 2 marks in an exam.

**Q20 (c)**

Although more than a quarter of students scored all 3 marks on this question, the vast majority of the rest did not score any marks. This might have been due to the amount of data given in the question, regardless of the fact that the calculations were relatively simple to perform. Some clearly missed the 6.85 kWh shown on the photograph, as they often worked out the daily household usage based on it being just 1 kWh.

A small number of students incorrectly assumed that energy was calculated using Power / time rather than Power x time, so did not gain access to marks.

**Q21 (a)**

A relatively straightforward calculation using the wave equation, although the key to progressing from 1 mark to 3 marks was identifying that the length of the column shown was equivalent to half a wavelength. Students might have been more comfortable with a node to node distance, rather than antinode to antinode, but there were a number of students who used other fractions of wavelength as the length of the column, which resulted in commonly achieving just one mark.

Almost all of the students scoring 2 marks had an incorrect or missing unit for frequency. Apart from these, there were very few mistakes made on a generally well-answered question.

**Q21 (b)**

A descriptive question, although still related to the wave equation. Although the question clearly stated that the aim was to produce the same frequency, a number of incorrect answers described how the increase in the speed of sound would result in an increase in frequency. Those who clearly understood that it was the wavelength that needed to increase often picked up another mark by stating the recorder needed to become longer. Most, however, failed to describe how this could be achieved.

Of course, not every student would be familiar with such instruments, so some leeway was given to those who had the right idea. For example, a number of students after correctly identifying that the wavelength would get longer suggested making the middle section of the recorder longer. This was credited although this is not what really happens with the instrument in the question (sections slide further apart).

**Q21 (c)**

A difficult question at the end of the paper, which the majority of students did not adequately access. However, there were not many blank responses, suggesting that students were generally able to reach the end in sufficient time. The majority of incorrect responses failed to recognise that the tension was proportional to the frequency squared rather than to frequency. A number of students who recognised the significant equations that should be used to answer the question failed to make much of an advance beyond simply showing the equations. The most common incorrect response was to simply calculate the ratio of the two given frequencies, and to state that the percentage increase in the tension was the same as the percentage increase in the frequency (1.85%).

**Paper summary**

The students taking this paper demonstrated a reasonable understanding of the mathematical demands of the specification, with some of the longer, multiple step, calculations (such as Q17a) scoring rather well.

The more descriptive answers were found to be more challenging, and questions such as Q14 and Q17b rarely scored very well.

Some of the questions required students to apply their understanding to novel situations, and these were also not answered very well. In particular, Q18bii and Q21c, which required students to adapt aspects of a core practical were not accessed by a significant majority. Many of the answers to parts of Q18 indicated that students were not familiar with a hands-on approach to the diffraction grating practical, as it was not clearly understood what each symbol in the equation represented. Having said this, students generally coped well with the unfamiliar graph presented in Q19, so managed to apply their understanding of the core practical quite well here.

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