Pearson Edexcel

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

This is the second sitting of a unit that had its first paper in the Summer of 2019. The unit assesses student understanding of the topics of Waves and Electricity (specification points 33 to 80). Section A has 10 multiple choice questions, whilst section B contains a mixture of short and long answer questions, calculations, and one 6 mark linkage question.
As with all A level courses, this paper assesses 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 are practicals that students are expected to have undertaken themselves, and questions about these practicals can be asked within the papers. On this examination there were significant questions about core practical 7 (which was answered very well on the whole) and core practical 4 (which was not answered as well). Discussion of these will follow in the main body of the report.

Section A – Multiple Choice

On average, students scored around 6 marks out of 10 on this section, with the most frequently correct answers being Q6 and Q7. The most difficult questions proved to be Q8, Q9 and Q10. For Q8, where the answer was D, it was interesting to see no common incorrect answer chosen (there were equal numbers of answers of A, B and C). Common incorrect answers for Q9 were A and C whilst Q10 had a most common incorrect answer of D.

Section B

Q11

This question was well answered. This is perhaps due to the fact that similar questions regarding energy levels have appeared on many papers of the legacy WPH02 examination of the previous specification. Students proved highly capable of converting the given frequency into an equivalent photon energy, and then converting that energy into electron volts. The only real surprise seen with a number of the scripts was a failure to recognise that the calculated energy of 0.31eV had to then be related to one of the possible "jumps" shown on the associated diagram. Quite a few students quoted an answer as a "Transition from -0.31eV to 0 eV". The only other regular mistake was to quote the correct transition the wrong way around. Students should remember that movements up energy levels correspond to incoming energy, whereas dropping down energy levels corresponds to a release of a photon (as with this question).

Q12 (a)

This question is about the de Broglie equation. Theoretically, an electron can have the same numerical value of de Broglie wavelength as a car, although it is impossible to assign a de Broglie wavelength to a car. This first part of the question was simply a calculation followed by a conclusion relating to a given student statement. As the statement referred to the car having to move at a very slow velocity, the only required answer was the car speed, although many performed calculations to determine the de Broglie wavelength too.

The speed and mass given as data lines in the question unfortunately resulted in a number of students performing a de Broglie wavelength calculation using the speed of the electron with the mass of the car, which was not acceptable for marking point 1. Quite a few students also did two separate calculations, where both the electron and the car were moving at the speed given for the electron. This resulted in two different de Broglie wavelengths being calculated which made it unlikely that marking point 3 would be awarded.

The majority of students picked up marks on this question, with many scoring all 3. A small minority calculating the correct speed followed it by saying that this speed would be impossible to achieve, which is not answering the question (the answer had to refer to whether the car was moving very slowly or not).

Q12(b)

A number of answers to this question were heading in the right direction but were too vague to achieve the mark. Most of these centred around the idea that the car was too big or had too much mass. A significant number of students focussed on the small speed calculated in the previous part of the question, stating that it would be impossible for a car to travel at such a slow speed. Technically, however, a car starting from 0 m/s and increasing speed to 1 m/s must for a very brief time be travelling at the speed calculated in (a) so it is not an impossible speed.

Q13 (a)

This part of the question was answered very well indeed. The majority of incorrect answers were from students who appeared to be attempting to calculate the power rather than the energy (330W being the most common incorrect answer). The time of 40 minutes given in the stem of the question was not actually required for part (a) but a significant number of students calculated a current and then used W = VIt to calculate the answer – most of these turned out to be correct as well.

Q13 (b)(i)

Another generally well answered part of the question. The only main issues were for candidates who failed to convert kilometres per hour into metres per second.

Q13 (b)(ii)

Although the answer for part (i) was required in order to answer part (ii), a significant number of students used this time in the wrong part of their calculation. For marking point 1, students were expected to use the time for the whole journey with the total charge to establish the average current. However, a number of students used the 0.45 seconds from (i) with the 36,000 Coulombs to achieve a huge current. This generally resulted in a failure to get any further in the calculation as the 0.45 seconds was needed for the next part of the calculation. Few students achieved all 3 marks on this part, but most students who attempted it picked up 1 or 2 marks.

Q14 (a)

This is the 6 mark linkage question, which required students to link ideas in a logical manner to come to a conclusion. The question relates to a potential divider circuit containing a thermistor. The circuit is intended to be used to operate an air conditioning unit via an external circuit which can either be placed across the connections XY or YZ.

All of the indicative content points were seen often in student's answers, although the early points regarding the operation of a thermistor tended to be more commonly awarded.

The first linkage mark was awarded for seeing any three of the first four indicative content points. The other linkage mark was awarded for seeing both of the last two indicative content points. As indicative content point 6 was a 50:50 choice between XY or YZ, this point could not be awarded unless accompanied by a reasonable description of why it needed to be across XY.

On questions relating to the behaviour of thermistors and light dependent resistors, it is worth students remembering that references given to particles in the question require students to be specific about which particles are involved in this particular situation. In this case, electrons needed to be mentioned.

A small number of candidates were clearly writing an answer for a filament lamp, which displays a behaviour almost completely opposite that of the thermistor, so these students usually did not score any marks as all of the arguments suggested that increasing the temperature increased the resistance of the thermistor.

Q14 (b)

This calculation proved to be reasonably well done, with a significant number of students scoring 2 or 3 marks. The main cause of mistakes was a confusion over the correct current and potential difference values to insert into the equations. A number of students calculated the current in the circuit for when it was dark, then assumed that the current would remain the same when it was dark. As such, they often scored the first two marks, as the second marking point only required one of the two resistance values to be correct.

Although the answer should technically be a negative value, students leaving the answer as a positive value were accepted.

Q15 (a)

This was another generally well-answered question, with most students accessing at least 1 mark. A common mistake came from students forgetting that the diameter was the measurement being made, rather than the radius or the cross-sectional area. The measurement of the resistance could have been undertaken directly with an ohmmeter, and most of the students obtaining the third marking point achieved it using this approach. Those considering use of both an ammeter and a voltmeter often forgot one aspect of either the quantity being measured or the piece of apparatus being used.

Q15 (b)

This is a familiar question, although many students failed to gain the first marking point to explain how the cross sectional area was obtained. Marking points 2 and 3 were much more commonly seen, and the majority of candidates suggesting an appropriate graph to draw were able to determine what should be done to the gradient to calculate the resistivity. Some of the weaker answers suggesting plotting the potential difference against the current, which could not result in establishing the resistivity.

Q16 (a)

This question is a standard definition, and it was generally answered well by the students in this examination. The main reason why some students did not attain the first marking point was due to not being specific enough about the direction of the two waves eg “a stationary wave is formed when two waves travelling in different directions meet”. Some students did not score the second marking point as they focussed solely on describing the nodes and antinodes rather than discussing superposition.

Q16 (b)(i)

A very well answered question on the whole although some students who rearranged the equation to make K the subject of the formula had some issues when dividing by ms^{-1}. Although the two marks were simply for seeing the correct units for each of the quantities, there did need to be evidence that these units had been used correctly in order to achieve the final unit outcome. Although not penalised, a number of students divided the units ms^{-1} by ms^{-1} to state that the units of K = 1.

Q16 (b)(ii)

This was a multiple-step calculation that was generally answered very well indeed. Many students achieved the full 5/5. There were many factors that contributed to the answers that did not achieve full marks. In particular, some students did not recognise that the wavelength for this diagram was $2L/3$. A small selection of students assumed that using the equation $v = \sqrt{(T/\mu)}$ was all that was required to achieve the wind speed, leaving their answer as 330 ms^{-1} . Another similarly small number of students failed to square root their $\sqrt{(T/\mu)}$ term, leading to a much higher (and unrealistic) value of wind speed.

Q17 (a)

The answers to this question were generally quite disappointing with most students clearly not understanding what the question was asking them to consider. A significant number of students stated that the ultrasound could not travel through air at all.

Q17 (b)

This question required students to do a pulse-echo calculation to make a decision about whether the pulse was reflected by a crack or from the base of the rail track. A further level of difficulty was introduced by the use of a graph from which data had to be extracted. A large number of the students failed to read the times from the graph correctly, often assuming that the reflected pulse arrival time (30 μs) was the total travel time (not realising that the transmitted pulse had not appeared on the trace until just after 5 μs. In spite of this, it appeared that many students had clearly recognised that the travel time included the time to travel to the crack plus the time for it to return. Of the two different methods shown on the mark scheme, both were seen quite regularly during the marking period.

Q17 (c)

This was another part of the question not answered very well. Too many students simply stated that the ultrasound was reflected at the first crack, not making it clear that either all of the ultrasound was reflected, or that the ultrasound did not reach any deeper cracks in the rail. Students should be aware that ultrasound reflects from all boundaries between contrasting materials but that when the boundary represents a small change in density, a significant proportion of the ultrasound continues to the next boundary. Thus stating that the ultrasound is reflected at the first crack does not imply that none of it reaches the second crack.

Q17 (d)

A number of students focussed on discussing the need for a pulse to return before the next pulse is sent. This has been the answer to some ultrasound questions in the past, but was not relevant to answer this question. As such, the responses to this question very rarely gained both marks, with a significant majority scoring no marks.

Q18 (a)

This definition has become a standard question in a number of papers over the past few years (on the previous IAL specification paper WPH02 as well as this one). Students generally gave good answers, although there continues to be some confusion about the mixing of planes and directions. The two alternatives on the mark scheme are not mix-and-match so if the student states that the vibrations are in one plane, for the second marking point they must state that this includes the direction of wave travel. There are still a number of students stating "the vibrations are in one plane which is perpendicular to the direction of wave travel".

Q18 (b)

This question proved to be far too difficult for most students to access. Unfortunately as the question only gave two alternatives for what the refracted ray could be, there was no mark for stating which one it was (unless linked to some correct physics). The fact that some of the planes of the incident light would be reflected meant that the refracted light could not be unpolarised. Although a small number of students had the correct idea, they often could not use the correct language to explain it. However, almost half of the student responses stated that the refracted light was unpolarised, which was unlikely to achieve a mark.

Q18 (c) (i)

This question required students to combine an understanding of trigonometry with equations given in the equation sheet in order to derive an equation for the Brewster angle. Most students were aware that they would need to use the equation $n_1\sin\theta_1 = n_2\sin\theta_2$, but the first marking point was only awarded if they had adapted it to match the given information. In spite of this, the majority of candidates achieved this mark. The two biggest hurdles to students were the failure to realise that sin $(90 - \theta)$ = cos (θ), and that sin/cos = tan. A significant number of candidates were able to do this proof and achieved all 3 marks.

Q18 (c) (ii)

This question was intended to be a straightforward calculation, using the formula that had been given on the previous page. In general, the answers were very good with the majority scoring a fully-correct two marks. The main issues with the incorrect reponses were a failure to get the refractive indices the correct way around in the formula and a failure to realise that they were to use the equation that had been given in the previous part (a number of candidates started off their answer by stating $n_1\sin\theta_1 = n_2\sin\theta_2$.

Q18 (c) (iii)

This question was generally poorly answered, with many students not understanding that different colours could have different values for refractive index. Too many students confused themselves by focussing on the equation $\theta_B = r + 90°$ to conclude that the larger the Brewster angle, the smaller the angle of refraction. What was not realised by these students was that for this equation, the larger the value of r simply meant that the angle of refraction was greater when the Brewster angle was achieved – not that they refracted more.

Q19 (a) (i) & (ii)

These parts of the question were generally answered quite well. It was pleasing to see that so many students correctly answered part (i). Such questions are often left incomplete by students as there is no answer line for the student answer. However, most of them did locate a position of minimum pressure, and most of these students located it correctly.

For (ii), there was a little more difficulty, but most identified that either the compressions or rarefactions were always representative of zero displacement. However, many students only considered that rarefactions or compressions were at zero displacement and not both. The main cause of not achieving the marks here was generally down to poor drawing – a significant number of candidates did not continue their diagram beyond the middle compression, making it difficult to achieve any marks as they had not represented what happened at the final rarefaction and compression towards B.

Q 19 (b) (i)

Perhaps the most disappointingly answered question on the whole paper. The second alternative of marking point 2 was the only mark seen on a regular basis – all the more disappointing as the photograph provided showed quite clearly a metre rule between the loudspeaker and the microphone. It seemed quite clear that the majority of students did not have any knowledge of how this practical was performed, with most simply stating that a distance and time needed to be recorded and to divide one of them by the other. This is a core practical exercise which is a compulsory part of the course, but most students did not demonstrate any understanding of it. It is worth noting that although the mark scheme allowed both phase and antiphase for marking points 1 and 3, it is much easier to observe on the 2-beam oscilloscope if the two waves are in antiphase.

Q19 (b) (ii)

This question was also not answered very well. This is primarily due to the fact that the majority of students did not refer to the oscillosope display, as directed by the question. It needed to be clear what was actually being read from the display, and most students did not make this clear enough.

Q19 (b) (iii)

This question scored reasonably well for most students, although most struggled to achieve marking point 3 due to the requirement for "percentage uncertainty" to be mentioned. Most achieved marking point 1, although some missed out on marking point 2 due to only calculating one of the two wavelengths. There were very few students who failed to convert the kHz into Hz for the calculation, so most established that the wavelengths were in the order of cm. Only a small percentage of students left this answer blank, suggesting that they had enough time to complete the whole exam paper in the alloted time.

Paper Summary

Although this is only the second time this paper has been taken on this specification, students appear to be getting to grips with the more demanding calculations very well. In particular, question 16 (b) (ii) was answered much better than expected, considering the different steps required in the calculation. The linkage question, question 14a, was also answered reasonably well, compared with other linkage questions on this and other units of the new specification so far.

Unfortunately, there were a significant number of items (particularly parts of questions 17, 18 and 19) that did not score as well as expected. In particular, the core practical description for Q19 (b) (i) was answered very poorly considering that it was something that was expected to have been covered by all students during the course. Across the full A level course, there are 16 core practicals. There is an expectation that students will know these practicals very well by the time they sit the examination, so detailed questions can be asked of these practicals. On this paper, students appeared to have a much better understanding of one of the other core practicals, calculating the resistivity of a wire. However, the core practical to measure the speed of sound using a 2-beam oscilloscope is a new practical (resistivity of a wire was also on the previous specification), so students should be prepared for questions about aspects that are new for this specification.

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