Examiners' Report
Principal Examiner Feedback

January 2020

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

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Grade Boundaries

Grade boundaries for all papers can be found on the website at:
https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

January 2020
Publications Code WPH12_01_pef_20200305

Introduction

This is the third 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 5 (Question 11) and core practical 4 (parts of Question 17). 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 Questions 3 and 5 being the ones that were most regularly correct. Question 2 was the least well answered question, with only just over a quarter of the candidates getting this correct. The majority of incorrect answers were those who chose Option A.

Section B

Question 11 (a)

The vast majority of candidates here clearly realised that with the string showing 4 loops, this equated to 2 full wavelengths, so dividing the length of the string by 2 to achieve the answer. The majority of those who scored 0 marks gave an answer which was twice the length of the string rather than half of the length of the string. The small percentage of candidates scoring just 1 mark generally had no units on their answer.

Question 11 (b)

This part of the question was answered less well than expected. Although more than half of the candidates achieved the full score of 3 marks, over a third scored 0 marks. This was largely due to an inability of candidates to recognise that the tension in the string was equivalent to the weight hanging from the end of the string. A significant number of candidates also felt that the mass per unit length was not the symbol μ from the wave speed equation, often multiplying the mass per unit length by the length of the string. A small percentage of the candidates clearly expected to have to use the answer from part (a) in their calculation for part (b), resulting in an incorrect equation being used.

Question 11 (c)

The most common approach to answering this equation came in the form of candidates citing the equation $v = f\lambda$, but most of these did not consider that a change in frequency might result in a change in wavelength. Even those who did often failed to recognise that this would result in the wave speed remaining constant. It was hoped that candidates having just completed a calculation in part (b) would use that equation to demonstrate that with no change in T or μ the speed would remain the same – however, very few did approach the question from this angle. Overall, the majority of candidates scoring 0 marks simply assumed that as frequency decreased, speed decreased (perhaps assuming that wavelength had remained constant).

It is worth candidates remembering that when one term in an equation changes, they need to consider what might potentially happen to all of the other terms in the equation.

Question 12 (a)

Part (i) was generally well answered, with many candidates scoring both marks. Even those who did not gain both marks often scored 1 mark for calculating the power (which was "per second", rather than the "per hour" the question had asked for). Part (ii) proved more difficult for most candidates, as only a small number of candidates managed to compare values that were in the same units. The most common mistake was to start with a correct calculation of the number of Joules per year required by the Earth in 2014 (8.6×10^{19} J) but then to compare it with the energy produced by the solar panels in 1 hour (3.6×10^{19} J) and stating that the solar panels would not be able to generate enough electricity for the whole world. The table in the mark scheme shows only some of the methods that were employed successfully by candidates, and "per second" calculations were also accepted here.

Question 12 (b)

It was quite clear from the question that sand storms would result in the solar panels being covered in sand. So the expectation was that candidates should produce some explanations about how this would reduce the power generated. Of the four options on the mark scheme, the first alternative was seen most often, although options 3 and 4 were also seen regularly. A significant majority of the candidates scored at least 1 mark on this question.

Question 13

This question was generally not answered very well. The descriptions given were often quite vague and not scientific enough to gain credit with statements such as “the ultrasound bounces back” being quite commonly seen. Of the 6 indicative content points, the first one was by far the most often awarded, followed by indicative content points five and six. It was very rare to see any candidates explaining that the reason for the reflection was due to a change in density of material (indicative content point two), and the other two indicative content points (three and four) were often intimated but not well described. A number of candidates focussed on descriptions that were more relevant to questions on previous examination papers testing this content. This included quite frequent references to “one pulse must return before the next one is sent”. A number of candidates also focussed on different types of interference or superposition taking place between the emitted and reflected waves.

Question 14 (a)

This question was answered well by most of the candidates as the definition had been clearly remembered. The vast majority of those not achieving the mark failed to include any indication of “minimum” in terms of energy (“smallest”, “lowest” and “least” were all accepted).

Question 14 (b)

This question proved to be quite a good discriminator of candidates, with reasonably equal numbers achieving 0 marks, 1 mark and 2 marks. Many identified that ultraviolet has a higher frequency or photon energy than visible light. However, many did not clearly link this to either the threshold frequency or work function. Considering that candidates had been asked to define the work function in part (a) of the question, it had been expected that candidates would take this route into part (b), but the majority used the approach relating to frequency.

Question 14 (c) (i)

This was a generally well answered question. The most commonly awarded mark was MP3 as most recognised that the ammeter reading increased. Very few of those who failed to recognise this scored MP1 or MP2. The link to a rate (e.g. per unit time) was required for marking point 1, as was the word “photons”, making this the mark that the majority of candidates did not achieve. In spite of this, many linked the increase in photons with the increase in electrons released so achieved marking point 2. Some candidates clearly suggested that unless the frequency was increased, the current would not increase, concluding that the ammeter reading would remain the same.

Question 14 (c) (ii)

Although a 4 mark question, very few candidates scored 2 or 3 marks here, as the understanding required to allow them to progress beyond the first marking point was often not there. To reduce the ammeter reading to 0 μA, the power supply had to be providing electrical energy that perfectly counteracted the kinetic energy of the electrons in order to stop them from moving around the circuit. This link was tricky for many, with candidates either choosing to suggest that the kinetic energy was 0 when the current was 0, or substituting numbers into the ½ mv^2 part of the photoelectric effect equation. Those progressing beyond marking point 2 generally scored all 4 marks, and a third of candidates achieved this.

Question 15 (a)

A number of candidates found this explanation question difficult. When questions ask about refraction of light from air into glass, candidates would be expected to discuss the change in terms of the change in (optical) density. However, such terminology was not relevant to changing depth of water for water waves, as the density of the water was the same either side of the boundary. In addition, very few candidates chose to add to the diagram as suggested in the question. Although both marks were achievable without adding to the diagram, for some it was easier to show the change of direction of wavefronts rather than trying to describe it in words.

Question 15 (b) (i)

This question required multiple steps to be taken in order to achieve the answer and candidates generally coped with this very well indeed. Although such theory is generally applied to light waves, the same calculations could be performed for any type of wave, and most candidates did not appear to consider that this was not a light wave when answering the question. Most calculated the two speeds and large numbers recognised that the ratio of speeds at the boundary could be used to establish the angle of refraction. A small number of candidates substituted the speeds in the incorrect way around, leading to an error on their calculators. However, more than half of the candidates completing this question managed to achieve all 5 marks.

Question 15 (b) (ii)

Unfortunately, a significant number of candidates did not really use the equations to show that the depth of the water was greater than 170m. These candidates typically stated that deep water is when the depth is greater than λ / 2 and then did 342 m / 2 = 171m. This was not really answering the question, as the data was expected to be used in two separate formulae to show that the same value for velocity was achieved on both occasions. Most candidates achieved the first marking point but a significant fraction did not recognise the need to back this up with a second calculation using the deep water equation. Due to the reasons above, the majority of the candidates scored either 0 or 1 mark on this part.

Question 16 (a)

Understanding of the Huygens' construction was poorly understood, and many did not refer to it at all in their answer. The majority of marks scored were for the idea that the waves spread out as they passed through the gap. A significant number of candidates discussed the interference pattern after passing through the gap, which was not what the question was asking candidates to explain.

Question 16 (b)

On such a diffraction pattern, the intensity on the screen is clearly greatest in the middle of the pattern, and many of the candidates achieved the first marking point for having some form of maximum shown at the centre of the line AB. However, far too many candidates considered that there would only be one of these maxima and drew a single "hump" as the whole graph. A few candidates misinterpreted what they had been asked to do, as they simply drew a sketch graph of a straight line travelling through "the origin". Marking points 2 and 3 were less commonly achieved by candidates, but there were still a reasonable number who interpreted the photograph correctly to score all 3 marks.

Question 17 (a)

This definition was not well remembered on the whole, even though it is a standard definition that has appeared on examinations in previous Edexcel specifications. The main mistakes made were to either not be clear enough about what the energy is supplied to, or to simply imagine that e.m.f. is a force.

Question 17 (b) (i)

A very well answered calculation question, with a significant majority of the candidates scoring both of the marks here. Although the equation for e.m.f. does not appear on the equation sheet, most of those who achieved the marks used the equation rather than going along the "sum of e.m.f. = sum of p.d." route. One or two candidates seen calculated the resistance of the whole circuit first, then subtracted the resistance of the external circuit from this, and then divided by the current to get the answer. Although more of a long way around the calculation this was accepted for the 2 marks also.

Question 17 (b) (ii)

Considering that this is a core practical, knowledge of how to draw the graph to determine the internal resistance was often poorly demonstrated. The first marking point was quite straightforward to achieve, although almost 20% of the candidates failed to score any marks on this question. Although the mark scheme shows three different methods used to achieve the marks, the majority of candidates used the method described in the first alternative on the mark scheme. In spite of this, many failed to make it clear that the gradient needed to be measured or calculated. Also, many candidates failed to recognise that the gradient would be negative so that it was equal to the negative of the internal resistance. Some were also clearly unsure whether R or r was the internal resistance.

Question 17 (c)

There were a number of approaches to achieving the marks on this question. Although it was only necessary to calculate the circuit current or the potential difference across the fixed resistor (marking point 1), some candidates calculated both, so were thus able to use $P = VI$ for marking point 2. The key issue, however, was that a significant number of candidates did not calculate either the current or the p.d. correctly, leading to incorrect substitutions into a power equation. This prevented them from being able to access marking points 3 and 4. Once power values had been correctly calculated, there were then three alternative methods that could be used to show that the student was incorrect. The majority calculated that the power had dropped to 86% of its initial value, deducing that the student was incorrect. Some calculated the loss of power as 14% and then compared it with the student suggestion that it should have fallen by 30%. The final alternative was to calculate the initial power of around 15.5W (depending upon the method used) and calculate 70% of this (around 10.9W), concluding that this would be a lot less than the true value of 13.4W.
In questions such as these, it is worth noting that a decision needs to be made in terms of whether the student was correct or not. On such questions, the final answer mark cannot be awarded if reference is not made back to the validity of the initial statement.

Question 18 (a)

The fact that the first two marking points were relatively simple to achieve is reflected in the scores achieved by candidates, with the vast majority scoring 2 or 3 marks. Although many would have recognised that the light would have travelled

so fast that it took hardly any time to reach the observer, either a calculation needed to be performed to show this, or a comment needed to make reference to this. As a result, many candidates failed to achieve marking point 3. As with the previous question, there needed to be a statement at the end of the answer to assess whether the teacher was correct or not.
If assessing whether a stated value is correct or not, it is not always true that the stated value will be exactly the value gained from a calculation. A small number of candidates calculating 2.94 seconds suggested that the teacher was not correct as the time was not 3 seconds. However, 2.94 seconds is close enough to 3 seconds to make the statement true.

Question 18 (b) (i)

A simple calculation with a majority of the candidates scoring both marks. The main causes of not achieving marks related to incorrect usage of the formula, power of 10 errors, and unit errors. A number of candidates assumed that micro represented a power of 10^{-3}, so achieved an answer of 750 C instead of 0.75 C.

Question 18 (b) (ii)

Another relatively simple calculation, again with the majority of candidates scoring both marks. A surprising number of unit errors prevented some candidates from achieving marking point 2, but otherwise it was answered well.

Question 18 (b) (iii)

A 3 mark calculation question that was generally answered very well. As a “show that” question, it was required for candidates to show their answers to at least one more significant figure than the value given in the question. Seeing as the answer to 3 significant figures came out to be 0.235 (Ωm), it was perhaps unsurprising that some of the candidates who failed to score the final mark wrote their answer down as 0.23 Ωm.
Some candidates who had the correct answer did not score full marks as they failed to use the correct powers of 10 in their calculations for cross sectional area. Candidates are encouraged to look back through their working to establish where the power of 10 error was made if their answer comes out to be 10,000 times bigger than the “show that” value. Simply dividing their calculator answer by 10,000 to get 0.24 does not achieve all 3 marks if the powers of 10 shown in their calculations are incorrect.

Question 18 (b) (iv)

Realistically, the only answer which could feasibly explain the huge difference in resistivity is the first option shown on the mark scheme. However, the second alternative was accepted as it was commonly noted from the photograph provided in the paper that the diameter of the channel varied. A number of candidates focussed on the difficulty of being able to measure some of the listed properties, but these were not considered significant enough, particularly as there was no indication from the question that there might be some uncertainty in the value. Some candidates were clearly thinking along the right lines by describing the heating effect on air, without mentioning ionisation. However, the question paper had already made it clear that the effect was generated by heating of the air causing rapid expansion, so simple discussion of heating was not credited.

Question 18 (c) (i)

This question discriminated very well, with significant numbers of candidates getting each of the possible mark totals. Marking point 3 was the most often achieved, although marking point 2 was also seen very often. Some candidates neglected to discuss the fact that the energy levels were discrete, so did not achieve marking point 1. Also, many failed to link the energy of the released photons to the frequency that was emitted. In spite of this, the general theory was well understood by a significant majority of the candidates here.

Question 18 (c) (ii)

It was good to see that virtually all of the candidates attempted the last question, indicating that very few candidates had any issue with time to complete the examination. Almost half of the candidates achieved the mark here, with the main mistakes being to state other correct facts that were not relevant to the question e.g. oxygen and nitrogen have different numbers of electrons.

Paper summary

The candidates sitting this paper appear to have coped well with its demands, and have answered some challenging questions very well indeed. In particular, the multi-step calculation required for question 15 (b) (i) was correctly answered by a majority of the candidates. On this occasion, the linkage question (Q13) was not answered as well as in the October 2019 series, which was surprising considering that the topic of ultrasound scanning should not be an unfamiliar concept.

As with the October 2019 paper, there were some disappointing answers to questions related to core practical activities. In particular, the lack of understanding about the meaning of the terms in the equation $v = \sqrt{(T/\mu)}$ was quite worrying. The issue appears to be the same as it was with the October 2019 paper where the core practical question that underperformed was one where the practical concerned had only been introduced to the course for the new specification.

An encouraging feature of this examination was that very few candidates appeared to be attempting to answer questions using answers from previous mark schemes that were not relevant to the questions posed in this examination. The candidates also appeared to have a much better understanding of the need to make conclusions when being asked to assess “whether the student was correct” or “whether the teacher was correct”. On this specification such concluding statements are required on certain questions in order to access the final marking point.

Although definitions cannot contribute more than 10% of the marks on a paper for this specification, it is still useful for candidates to take the time to learn definitions. On this paper, descriptions of e.m.f. and the Huygens’ construction were not very well constructed.

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom