Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

January 2019

Pearson Edexcel International Advanced Subsidiary Level
In Physics (WPH02)
Paper 01 Physics at Work

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January 2019
Publications Code WPH02_01_1901_ER
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Introduction

This paper assessed candidates on their knowledge of d.c. circuits and waves with a range of contexts in which to apply their physics.

All candidates made a good attempt at the questions on this paper and overall achievement was very similar to the October 2018 paper. In many cases it was clear that candidates had had exposure to past papers and markschemes, for example Q13,Q14. However, in some questions where the context was unfamiliar, some candidates had difficulty with applying the physics into this new context or were unable to recognise the relevent physics to use. Perhaps these candidates are too reliant on past markschemes, and would benefit from more exposure to real applications of physics. In particular, candidates had difficulty with Q14(c) and Q16(d) which were a less familiar style of question that required candidates to have a different approach.

Section A – Multiple Choice

	Subject	**% scoring correct answer**
1	Units	83
2	Resistance network	89
3	Polarisation	64
4	Emf and internal resistance	68
5	The transport equation	71
6	Electron diffraction	20
7	Current-voltage characteristics	76
8	Diffraction of waves	96
9	Transmission of light in glass	57
10	Power and efficiency	58

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Question 11(a)

A generally well tackled calculation. Candidates who did not score full marks made errors with rearranging the equation or failing to convert 4.1 eV into J by multiplying by e.

Question 11(b)

Many candidates linked this clearly to intensity and so scored Mp1. A significant number failed to refer to photons and simply repeated the information given in the question "more photoelectrons being emitted per second". With no reference to photons a candidate could score a maximum of 1 mark. A pleasing number of candidates did refer to the rate of emitted photons, rather than simply the number of photons, perhaps guided by the information in the question. Some candidates referred to the energy of the photons as E=hf, probably trying to link with the power of the source. This would have scored no marks.

Question 12(a)

This was a different approach to using the resistivity equation in asking candidates to determine the thickness of the carbon track. Candidates found it difficult to work out which was the relevent cross-sectional area to use in the calculation, using the length of the carbon track instead of width, or, despite the diagram, relying on more familiar calculations, assumed the track was circular. This demonstrated that some candidates were unable to think independently when the required method is changed.

Question 12(b)

The responses to this question indicated a lack of understanding of potential divider circuits. Mp3 was the most likely mark awarded although this was not commonly seen. The idea of the ratio of p.d.'s and resistance for Mp1 and 2 were rarely awarded. Even the mention of a potential divider circuit for Mp1 was not commonly seem, perhaps indicating that candidates did not recognise this as a potential divider circuit. Those who came close to scoring 3 marks failed to score as they found it difficult to describe.

Question 13

Candidates made a good attempt at this question with most candidates picking up some marks. Some candidates were slightly confused by the question which mentions stars producing absorption spectra, but then specifically mentions hot gases. It was common to see answers that discussed both the absorption and the

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emission of photons. Many candidates focussed their answers on the different spectra, often scoring no marks. From previous markschemes candidates realised that they should quote the equation *E=hf* but this needs to be used to support a relevent argument and therefore candidates need to define all terms, thereby demonstrating that they understand its relevance to the question.

Question 14(a)

Candidates generally answered this well. For Mp1 it was most common to see their desciption in terms of light travelling from a more dense medium to a lower dense medium. It was rare to see a description relating to refractive index, or, even more uncommon, velocity. Mp2 was more commonly awarded than Mp1 although some candidates failed to score this mark because they failed to state *incident* angle.

Question 14(b)

Those candidates who were familiar with the equation $\sin C = \frac{1}{\mu}$ were likely to be most successful at this calculation. Those relying on the equation in the formula sheet needed to recognise that $r = 90°$ and rearrange the formula accordingly. Some calculated the angle of refraction to demonstrate that the light is not total internal reflected but some then did not link their conclusion to refraction.

Question 14(c)

Candidates were clearly unsure on how to approach this question. Mp2 was the most commonly awarded mark for a statement that the data is given to more than two significant figures. Few recognised the need to determine the corresponding change in the refractive index to a 1 g change in the mass of the sugar. Some candidates calculated the critical angle values or, the values for refractive index that could be obtained over the range of the graph, to show that it is very small.

Question 15(a)

A question that has appeared on previous papers and most candidates scored marks. Mp3 was the least commonly awarded mark.

Question 15(b)

A question on nodes and antinodes requiring candidates to apply their knowledge in an unusual context. This seemed to confuse some. The idea of oscillations or vibrations was often absent and there was confusion over amplitude and displacement. Mp3 linking to the direction of the vibrations was rarely awarded.

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Question 15(c)

This was a question where not showing working could mean losing out on marks. Without clear working it was not easy to award method marks if an incorrect answer was given. An answer given as 20 kHz could be obtained by a student who has failed to apply one of the factors of two (Mp2 or 3), so with clear working could have scored up to 3 marks, but with no working would have scored 0. The more able candidates realised the importance of measuring across more than two nodes and recorded their measurement.

Question 16(a)

This question generally scored well with many candidates confident with using the idea of displacement as opposed to amplitude.

Question 16(b)

Most recognised that this was constructive interference. Candidates were less confident describing path difference and so Mp1 was less commonly awarded, especially as they needed to link closely to the context. Candidates were expected to realise that the path difference is 0, and not simply write the more standard answer that path difference is a whole number of wavelengths.

Question 16(c)

Unlike part(b) candidates could score full marks by describing path difference or phase difference. The statement that the waves are in antiphase was commonly seen. There was often a failure to write the condition for path difference correctly with some candidates unsure where to place the ½, the *n*, and the λ in relation to the brackets.

Question 16(d)

Most candidates did not realise that the path difference was half a wavelength, but decided that it was a whole wavelength and so giving an incorrect answer of 200 nm. This was very commonly seen.

Question 17(a)

The question indicates that this is the pulse-echo technique but some candidates attemted to describe the Doppler effect. Mp1 could still be awarded but they could not score Mp2 and Mp3. Those describing the pulse-echo technique appreciated they needed the time but failed to mention that the time needs to be measured. They then needed to describe how the measured time is used to calculate the depth/position of the baby with reference to an equation including the factor of 2. It was rare to award full marks in this question.

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Question 17(b)

This question was not well answered showing a lack of understanding of the Doppler effect with candidates failing to realise that this was a continuous liquid, not a discrete object. Candidates who realised the Doppler effect was involved often scored at least MP1 and MP3. MP4 was rare, with most candidates making reference to directional effects rather than the effect of speed. It was incredibly common, as usual, to claim that the changed frequency/wavelength could somehow be used in the wave equation to calculate the speed of the blood, showing a huge misconception in that equation. A minority of candidates could either quote the Doppler equation or correctly link the idea that the change in frequency/wavelength could be used to determine the speed, but failed to appreciate that they should indicate the relationship more clearly.

Question 17(c)

Responses to this question often demonstrated little progress from GCSE with many candidates not realising that this is to do with ionisation from higher energy X-rays. For Mp3 vague answers simply mentioning cancer did not score a mark. At this level it is expected that candidates realise, more specifically, that the danger is X-rays causing a change to the cells in the body due to ionisation.

Question 18(a)

This scored well. Common mistakes included using an incorrect value for the p.d. across the resistor such as 1.8V - the p.d. across the LED, or 6.0V - the emf of the battery. Mp1 could still be awarded for the use of $V=IR$ but could not score Mp2 and Mp3. This is a 'show that' question with the 'show that' value given in mA. Candidates were then expected to give an answer in mA.

Question 18(b)

This scored well. Candidates could use the 'show that' value from (a), or their calculated value. An ecf from part (a) was applied.

Question 18(c)

Candidates made a good attempt at this multi-step calculation. Mp1 and Mp2 were most commonly seen but many candidates struggled after that. In using the efficiency equation for Mp3 candidates needed to select the correct energies to substitute. The correct use of the 90% was awarded in Mp4. Some candidates tried to divide by 0.9 when they needed to multiply and so would have scored a maximum of 3 marks. Those who scored full marks wrote answers that were almost always incredibly clear in the steps they were taking in their calculation.

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Question 18(d)(i)

Around 50% of candidates got this correct. The most common mistake by candidates was not to include the term *V* as referred to in the question. For example *E=hf* was a common incorrect answer.

Question 18(d)(ii)

Nearly half of candidates failed to score on this question. It is expected that candidates use at least half of the graph when calculating a gradient. In this question many candidates did not notice that the line does not pass through the origin and did not take this into account in calculating the gradient. Likewise some candidates did not calculate a gradient but used corresponding points on the graph and would have limited their answer to Mp2 only. Some candidates, perhaps noticing that the value for Planck constant was on the facing page, wrote the usual 6.63×10^{-34} as an answer without any working. This would have scored zero.

Summary

This paper provided candidates with a wide range of contexts from which their knowledge and understanding of the physics contained within this unit could be tested.

Based on their performance on this paper, some candidates could benefit from more teaching time and extra practice on the following concepts and skills:

- Using graphs to obtain data for use in a subsequent calculation. At least half the graph should be used when calculating a gradient and to take into account a graph that does not start at the origin.
- Rote learning is good for short definitions but should be avoided in longer written answers as it does not always reflect the question being asked. Candidates would benefit from more practise at writing longer explanations.
- Writing down all steps in a longer calculation helps to secure marks if the final answer is incorrect.
- Application and discussion of physics in unfamiliar contexts. Candidates were often unable to apply the physics to less familiar contexts.

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