Examiners' Report
Principal Examiner Feedback

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

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Introduction

This paper enabled candidates of all abilities to apply their knowledge to a variety of styles of examination questions. Many candidates showed a good progression from GCSE to AS level, with prior knowledge extended and new concepts taught and understood well. Candidates who had experience of a wide range of practical demonstrations fared well on some questions (Q13 and Q17 in particular) as this helped them to apply their physics knowledge in different contexts.

Section A – Multiple Choice

	Subject	Percentage of candidates who answered correctly	Common incorrect response	Comment
1	E-M Spectrum and fibre optics	37	B,C	Candidates appeared to find the application of fibre optics difficult.
2	Waves in strings	36	B	Those responding with B recognised that the wave was stationary but thought that it was a longitudinal wave, maybe linking with sound.
3	Ultrasound scan	71	C	High scoring correct response
4	Total Internal Reflection	37	D	The common incorrect response had the inequality the wrong way around, but did recognise this as linked to wavelength as opposed to frequency
5	Thermistors	65	A,B	High percentage scoring correctly.
6	Units	70	A,C	High percentage scoring correctly.
7	Refractive index	58	C	The common incorrect response may indicate that candidates were less familiar with the orientation of the diagram with the wave originating from the bottom.
8	Diffraction	38	B	Candidates responding with D recognised that the wavelength is unchanged but thought that the speed would decrease, indicating some confusion between diffraction and refraction
9	Wavelength of a progressive wave	54	B	Incorrect B response does not link to phase but to amplitude
10	Drift velocity	28	A	Candidates needed to appreciate that the wires have the same p.d. and therefore the same current. The common incorrect response indicated that candidates thought the current in each wire would halve

Section B

Question 11

Q11(a) This mark was rarely awarded. Although many candidates clearly understood that connecting to the resistance wire at various positions would vary resistance, potential difference and current, few could state that the advantage the potential divider had over the variable resistor is that it would allow for the p.d. to vary from 0 to that supplied by the battery. It is clear, that even when candidates understand how a potential divider works, they do not understand why we would chose it over a variable resistor.

Q11(b) Common errors included powers of 10 and confusing resistance and resistivity. In addition, many failed to be awarded the final mark as they did not double their radius to give the diameter.

Q11(c) The majority of candidates answered well with answers of 2.1, 2.15 or 2.148. Common errors included mistakenly using 7.16 cm in the ratio of resistances to p.d. (so assuming the value was 7.16 Ω) and inverting the ratios (e.g. 40.0 / 7.16 x 12). Those that attempted to find current generally scored 1 mark, as in most cases they had mistakenly assumed the resistivity and diameter of the wire were the same and used them to calculate the resistance of the 7.16 cm section of wire.

Question 12

Q12(a)(i) Many did not attempt to calculate the power, so mistakenly substituted energy into Power = Flux × Area. Of those that did, a common error was the conversion from hours into seconds (÷ 3600), in some cases energy was multiplied by 60 or 3600.

Q12(a)(ii) Generally answered well. Common mistakes were to use the value of radiation flux as the input energy, or to invert the 2 energies.

Q12(b) Most scored 1 mark for the idea of low efficiency. The second mark was most often awarded to discussion of the size of the solar panel required. Other arguments made were generally too vague to be awarded the mark.

Question 13

Q13(a) Candidates need to either answer in terms of directions of oscillations or in terms of the oscillations in one/all planes. The same poor understanding of the word "plane" continues to prevent students obtaining full marks. Quite a few candidates failed to specify that unpolarised light had a "large number" of different planes available, with many saying things such as "more than one" or "a few". Candidates are still uncomfortable describing the direction of the wave travel as confined to one plane for the last marking point and so many scored no more than 1 or 2 marks for this question.

Q13(b)(i) There were few clear sequential answers for this question, with filter 1 often being ignored. The filters are referred to as first and second filters in the question and using these terms in their explanation would help to make it clear that reference is being made to two different filters. Candidates need to remember that there are no marks for repeating information given in the question as many simply talked about the filters being perpendicular and that they would block the light.

Q13(b)(ii) A difficult concept and not well answered. It is clear that this is a demonstration that many were not familiar with. A few students realised the only answer was that the plastic rotated the plane of polarisation of the light, although many seemed to think this was an active process. As such the use of the word component, essential for a full explanation, was rarely used.

Question 14

Q14(a) Generally well done. The most common mistake involved power of ten errors in not recognising the unit of μA.

Q14(b) Generally also well done with candidates choosing the correct value for V.

Q14(c) Most common marks were the appreciation that the voltmeter had a very high resistance, and that as a result there was very little current. Some students seem to think that the high resistance was not useful, coming to the conclusion that it was not suitable. The best answers used $\varepsilon = V + Ir$ to structure an argument based on high resistance leading to negligible current and no "lost volts".

Question 15

Q15(a) Quite a few candidates had learnt this definition well, although a significant number were still using amplitude instead of displacement and were not focussing on the fact that this occurred where waves met. Full marks could have been awarded by simple rote learning.

Q15(b)(i) A typical explain and QWC question on interference in an unfamiliar context. Most candidates understood that this was an interference effect caused by the two reflections of the light. The condition for destructive interference in terms of phase difference caused problems. Candidates knew it had something to do with "$\frac{1}{2}$" and "wavelength" but would misquote the expression $(n+\frac{1}{2})\lambda$. Common errors were failing to link path difference to phase difference or to link the interference to the amplitude. There were some that attempted to argue that some wavelengths would be the wrong size and would diffract rather than reflect (so that colour would not be reflected strongly).

Q15(b)(ii) This question was regularly misunderstood. Despite the question being labelled (b)(ii), many candidates missed the link to the diagram/explanation for (b)(i). Those who realised that, for blue light, the path difference must be 2 x d, the calculation was performed easily. For some, having realised 2 x d was the path difference, and then linking path difference to λ, they took a very complicated approach. Using the speed of light to calculate the time difference between the reflected waves, linking that time difference to the period of 1 wave (as it was constructive interference) and hence the frequency of that wave. Then, using the speed of light, to correctly find the wavelength. However, some took a cyclical approach, starting with d (rather than 2 x d), finding time period and frequency, and then calculating wavelength to reach the original value of d.

There were many reverse argument approaches that were not accepted. The two most common were, firstly to calculate the average of the blue wavelengths and show that when halved this was similar to d, and secondly, to calculate the range of the blue wavelengths (45 nm) and halve this (22.5 nm) which was then incorrectly converted to 2.25×10^{-7} m.

Question 16

Q16(a) Most students scored at least one mark here by attempting to describe the graph. Lots of incorrect statements were made about diodes and bulbs, a common claim was that the current reduces as the potential difference across a bulb increases. To gain both marks reference needed to be made both to diodes and filament bulbs.

Q16(b)(i) This question was not done well with just 28% scoring any marks. Most students failed to understand what the term distribution meant and so wrote about diodes instead. Most of those that did realise the readings were distributed unevenly failed to suggest a reason for this.

Q16(b)(ii) Only 5% scored more than 1 mark. Many failed to take into account that there was more than one light, omitting the factor of 12 which they needed to obtain by counting the lights in the photograph.

Q16(c)(i) Fully correct answers were common.

Q16(c)(ii) Although this is a fairly standard question it was not well answered. Many candidates did not realise that this was a question about energy levels, perhaps because it is used in a different context.

Question 17

Q17(a)(i) Although no previous knowledge of stopping potentials was expected (all information the students needed was given in the question), it was clear that those students who had seen this demonstration were more confident at applying the ideas of the photoelectric effect. Many candidates assumed that electrons were not emitted at all for reverse p.d.. In some cases, it was clear some candidates thought that the positive p.d. was the reason for the electrons to be emitted rather than the energy from the photons. For those that did correctly identify electrons being emitted, few mentioned the work function as the link to the “ultraviolet light of a particular frequency” mentioned in the question. However, most did understand that positive p.d. caused a positive Q plate, so an attraction to the electrons caused a current to flow. The negative p.d. was generally explained in terms of repulsion, rather than the requirement of energy to reach Q, which meant few explained the concept of “no electrons have sufficient energy”.

Q17(a)(ii) Many candidates did not link the doubling of intensity to any other doubling (apart from current - but that was given on the graph). Most limited their answers to the more vague descriptions of more/higher number. Similarly, despite current and intensity both being a rate (photons per second, electrons per second) most answers did not include the concept of rate (per second) at any point. As such most answers scored 0.

Q17(b) A poorly-answered calculation question. It was very common to see candidates assuming V_s was the velocity in $hf = \varphi + \frac{1}{2}mv^2_{max}$ rather than equating $E = V_sQ$ and the maximum kinetic energy. They needed to look back at the stem of the question to remind themselves what was meant by V_s. (Students should know that velocity is a lower case *v* and potential difference is an uppercase *V*).

Question 18

Q18(a) Candidates were often well rehearsed on the frequency responses for moving towards and away, although some students only described one or the other. There is a strong indication that a large number of candidates think the distance rather than the motion is the reason for the change in frequency. References to the frequency changing at a constant speed were relatively common. Many students failed to attempt to explain how the speed can be determined.

Q18(b) Many students found this question difficult, particularly as there were 3 different times given in the question. A significant number attempted to use speed = distance/time but then both the distance and time values inserted were actually times. The factor of 2 was often missed, so a correct answer was rare.

Q18(c) Although the question clued candidates in to discuss things in terms of wavelength, many steered well clear of this and talked about completely incorrect physics. A significant number also attempted to answer purely in terms of frequency, often using it to explain something about the number of readings that could be taken per second or the speed with which the waves would return, all of which was not worth any credit.

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.

A greater understanding of the context and question being asked would have helped many candidates. A sound knowledge of the subject was evident for many but the responses seen did not reflect this as the specific question was not always answered as intended. Practical demonstrations (or simulations) do help candidates with their understanding and application of concepts.

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

- Slow down during the multiple choice items so that key words in the command sentence responses are not missed.
- Do not leave a multiple choice answer blank.
- Remember to check responses if there is time at the end of the paper in case careless mistakes have been made, especially powers of 10 from missing prefixes of units.
- Set out all of your working in calculations for both show that questions and longer, multiple step calculations.
- In a longer explain question, refer back to the stem to remind yourself of the physics and of the information that you have been given.
- If a series of events has to be described do not spend all of your time describing one aspect.
- You will not gain credit for repeating information in the question.

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