Pearson

Examiners' Report
Principal Examiner Feedback

October 2017

Pearson Edexcel International Advanced Level
Physics (WPH02)
Unit 2: Physics at Work

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General Introduction

The specification examined and assessment structure of the paper is the same as that of the GCE 6PH02 paper. Section A of the paper contains 10 multiple choice questions while section B contains questions of increasing length and usually of increasing demand.

Unit 2, Physics at Work, examines dc Electricity and Waves providing a transition for students between GCSE and A2. Although there is no overlap with the other units, the skills and concepts covered, are used as a basis for the teaching of the concepts in units 4 and 5.

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

Section A – Multiple Choice

	Subject	Percentage of students who answered correctly	Comment
1	Waves	93%	A question linking diffraction to waves spreading around an obstacle.
2	Polarisation	38%	Students needed to appreciate that a polarising filter transmits only 50% of the power.
3	Change carrier density	29%	*n* is the number of charge carriers per unit volume and has unit m^{-3}. It is dependent on the material of the wire.
4	Diffraction	61%	Greatest diffraction occurs when the size of the gap is equal to the wavelength
5	Efficiency	70%	Students needed to apply the law of conservation of energy to appreciate that the total input energy is equal to the total energy output $E_{grav} + E_w$ and apply the efficiency equation $\text{Efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$
6	Resistance and resistivity	72%	Using $R = \frac{\rho l}{A}$ and substituting 2*A*, 2*l* and 2ρ gives 2*R* leading to 16 Ω.
7	Planck constant	58%	Unit of *h* is J s. The unit for Joule expressed in base units is kg m^2 s^{-2} so the unit for *h* expressed in base units is kg m^2 s^{-1}
8	Application of pulse-echo	45%	The time between the peaks is equal to the time taken for the pulse to be transmitted and reflected. Use $v = \frac{s}{t}$ with $t = \frac{40\ \mu s}{2}$
9	Application of pulse-echo	28%	If the transmitted pulse is too long then the next pulse is transmitted before the previous pulse has been detected as the time between pulses is too short.
10	Potential divider circuit	55%	The resistance of the thermistor increases as the temperature falls and, in a potential divider circuit, the p.d. across it will also increase. The circuit in A will produce a high p.d. across the heater when the temperature falls.

Section B

Question 11

(a) Many students were aware of the two conditions for Total Internal Reflection with the angle of incidence being greater than the critical angle being the more commonly scored of the two marks.
(b) Most students achieved MP1, with a significant proportion also achieving MP2 and MP3, either by calculating the critical angle, or the refractive angle. A small number of students calculated the critical angle but called it the refractive angle, and vice versa. The least likely scored marking point was MP4. Most just finished off by saying that the ray did not deflect (in line with the way the question had been asked). Some of the possibly more able students only achieved 1 mark, as they did an initial refractive index calculation and then based the rest of their argument solely on this - the fact that the refractive index is less than 1 results in refraction, so not deflected through 90 degrees. Unfortunately, more work was needed to demonstrate that it refracted, by working out an angle. There was evidence of confusion about the refractive index and the direction of the ray leading to incorrect answers.

Question 12

(a) An answer requiring reference to several aspects of the transverse wave all of which were seen missing regularly. MP1 needed mention of (1) oscillations/vibrations…and (2) of what (particles/molecules)… and in what (water). MP2 needed a reference of oscillations perpendicular…and perpendicular to what: propagation/ energy transfer/ direction of the wave travel. A vague answer referring to "motion" gives no idea whether the "motion" is that of the oscillating particles or the direction in which the wave is travelling.

(b) A question requiring students to use the formula for a straight line graph $y=mx+c$ in an unfamiliar context. MP1 was commonly not seen, either students confusing d for distance or they did not appreciate that they needed to state how v was to be calculated. Those who realised that a straight line graph was needed were then generally able to score MP2 and 3 with a range of different but correct graphs suggested, the most common v^2 against d. The most common incorrect graph suggested was v against d for students not sure how to manipulate the square root. The question asked the students to "describe" so the expectation is that students would write down their method rather than just show a sketch of the graph.

Question 13

(a)(i) Most students realised that the emitted frequency was given by the midpoint of the sinewave (400 Hz). However, common incorrect answers were 410Hz (the max point on the graph), 20Hz (peak to peak on the sinewave, 10Hz (the amplitude of the sinewave).
(a)(ii) There needed to be some comparison between the emitted and the observed wave. A common incorrect answer stated that "the frequency was decreasing". This is too ambiguous and was not awarded.

(b) There are two changes to note. The more commonly awarded was a realisation that the increase in speed gives shorter time period, and secondly, there is a greater range the frequency. Full range of marks were awarded.

Question 14

(a) Generally well done with most students recognising at least one compression.
(a)(i) Students were expected to recognise two points between which a wavelength could be measured and use a ruler to measure it. Most students were able to measure this to the correct precision although a small but significant number rounded their measurement or gave an incorrect measurement entirely.

(b) Two ideas that students needed to use; firstly that there is one complete wavelength between adjacent compressions/rarefactions and, secondly, that there will be zero displacement at compressions and rarefactions.

Question 15

(a)(i) Generally well answered, with many scoring all four marks by finding the energy of the photon using $E = hf$, converting it to eV by dividing by the electron charge, and comparing it with the value of the work function given in the question. Other, correct, ways of doing this were seen such as converting the work function value to Joules and then comparing it with the energy of the photon found from $E = hf$, or finding the threshold frequency and comparing it with the given photon frequency.
(a)(ii) This was not well answered, perhaps the idea of a 'rate' of change causing confusion and was often left blank. It was common to see the rate of incident energy as given in the question being divided by the charge on an electron

(b) A significant number of students correctly stated that one electron absorbs one photon as evidence for the particle theory of light. Less commonly stated was the idea that electrons would gradually gain enough energy to escape or, it would take time for the electrons to have enough energy to escape as evidence for the wave theory of light. Many students stated that the energy of the wave would build up gradually giving no reference to the electron. This was insufficient to gain the mark. Discussion of threshold frequency or intensity of incident radiation was not relevant here. The question clearly stated that photoelectrons were released instantaneously so the discussion of the time of release of photoelectrons was required.

Question 16

(a)(i) A significant number of students did not equate nodes with cold spots and antinodes with hot spots while others got them mixed up. More commonly seen was the correct link between cold spots and the waves meeting in antiphase or hot spots and the waves meeting in phase. Fewer students linked nodes with minimum or zero amplitude or antinodes with maximum amplitude, instead mentioning displacement which was incorrect. This was a QWC question.
(a)(ii) Students were generally confident with using the equation $v = f\lambda$ but many did not recognise that with a standing wave the distance between adjacent nodes is half the wavelength and so limited their total mark to one.
(a)(iii) A range of descriptions were permissible here linking to the idea that the position of the nodes and antinodes are constantly changing position. Many gave an answer in terms of hot and cold spots but this goes little further than the question and a link to the property of the standing wave was needed. If the turntable is rotating there should be no hot/cold spots.

(b)(i) MP1 and MP2 were more commonly answered. Fewer students linked their answer to path difference. This was a QWC question.
(b)(ii) A significant number of students did not answer this in terms of the path difference being $n\lambda$ for maxima and $(n+½)\lambda$ for minima which is what was looked for. Some students who attempted this confused path and phase difference

Question 17

(a) Despite the question referring to an atom many students answered this in terms of an electron.

(b)(i) This calculation was generally well answered. The main mistake was not knowing which way the transition would occur
(b)(ii) The wavelength is within the ultraviolet range.

Question 18

(a) Deriving requires more detail than just writing down the answer, and many did not show very much at all in the way of working out. There needed to be evidence that the candidate was applying the physics to the question and not simply copying formulae from the back of the paper. Quite a few did not make any attempt to show how they had worked out the resistance in the parallel section. MP2 was most often lost by students who decided that E = V – Ir rather than E = V + Ir.

(b) Students were confident with the use of $P=I^2R$ but did not choose the correct value for I, forgetting that the total current out of the cell would be 4 times that of the current through each bulb. Some, who realised this did not square the 4.

(c) This was poorly understood. A misconception that became apparent was that the motor would draw current away from the bulbs. Students could still, nonetheless, achieve MP4, which was the most commonly awarded mark. Despite parts (a) and (b) trying to lead the students into considering the internal resistance in the system, very few students realised that this part of the question was about the increased p.d. across the internal resistance, with any reference to p.d. rarely seen.

Question 19

(a) In order to plot graph there needs to be a range of values for p.d. and current taken and this needed to be made clear. Also, both quadrants of the graph needed to be considered - MP2 was awarded the least frequently. MP3 and 4 could be awarded from a circuit diagram. Many students did not consider how the p.d. could be varied and of those that did many did not seem to know the symbol for a variable resistor with thermistors (not appropriate in this context) or a “hybrid symbol” between a variable resistor, potentiometer and thermistor, commonly seen. Generally MP3 was awarded with most students knowing how to connect an ammeter and a voltmeter. The symbol for an LED was not well known.

(b)(i) This was answered fairly well. The main mistake was to misread from the graph to arrive at an incorrect value for current.
(b)(ii) A surprising number did not recognise that the resistance for negative values of p.d. is very large. Even if they were not familiar with the diode, the correct answer could have been obtained from the graph. Quite a number wrote 0 perhaps thinking that a horizontal line indicated a low resistance.

(c)(i) This question was expecting students to appreciate that the resistance of the LED would be very low.
(c)(ii) The question was generally answered well with most students gaining some marks although only a few scored 5. Many students calculated the current correctly for MP1 but a significant number were then unable to make correct use of the 95% or ignored it altogether. The reading from the graph for their value for current was handled well. MP1 and MP3 becoming the more commonly awarded marks in this question. MP4 was commonly not scored as students did not appreciate that they

needed to take the p.d. across the diode into account and assumed that the p.d. across the resistor *R* was equal to 6 V. This meant that they could not then score MP5.

(c) (iii) Of those who attempted this question, there were some good answers scoring full marks. The main issue here appeared to be students' lack of understanding of the definition of the volt which was crucial to answering this question. Those who did, had understood that the work done on a single electron moving across a p.d. of 1.8V was the p.d. multiplied by the electron charge. 77% of this is the energy of the emitted photon, so multiplying by 0.77 would give the correct value for the photon energy. A large number of incorrect answers multiplied 1.8V by the current read from the graph in the previous part for a time of 1s to give energy but this was not the energy of a single photon. If they had divided this value by the current divided by the electron charge and found 77% of this, they would have arrived at the correct energy value.

Summary

This paper provided students 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 students. 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 students with their understanding and application of concepts.

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

- Manipulation of rates of change within a mathematical process.
- Use of refractive indices as light travels from one medium to another where neither medium is air.
- Verifying an equation by plotting a straight line graph
- The wave and the particle nature of light
- Application and discussion of the physics in an unfamiliar context
- Analysing d.c. circuits especially with respect to p.d.
- How to show all steps when deriving an equation

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