Principal Examiner's Report

October 2016

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

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October 2016
Publications Code WPH02_01_1610_ER*

Paper Introduction

This paper, Physics at Work, covers waves, dc electricity and the nature of light. The 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.
Section A of the paper contains 10 multi choice questions of varying demand.
Section B contains short answer and longer answer questions with a range of demand, generally increasing through the paper.

Multiple choice Questions

Question number	Percentage scoring the mark	Common incorrect answer	Comment
1	76	C	Incorrect response gives an indication that whilst candidates know that a voltmeter is connected in parallel there is a lack of understanding that a voltmeter has a high resistance.
2	70	C	Incorrect response shows correct values but the ratio is the wrong way round
3	37	B	Out of phase by $\pi/2$ radians can mean that the path difference is 1.25λ.
4	64	A	Incorrect response gave a linear relationship but with resistance falling as temperature increased.
5	71	B	Incorrect response used a mis-rearrangement of $Q=It$ and so could not be correct. The correct answer derived the units from $V=W/Q$.
6	36	B and D	Whilst candidates may be familiar with the refraction of light they could not translate the same ideas to water waves and this gave a large range of incorrect answers..
7	59	D	A compression occurs half a time period after a rarefaction. Incorrect response indicated a whole time period.
8	66	C	The common incorrect response indicated that candidates thought that the amplitude would increase as the source of sound moved away.
9	74	C	This answer needed candidates to be aware of the wave property of electrons.
10	74	B	The incorrect response indicated a confusion with using the gradient to determine *r*. Possibly a misunderstanding of the difference between 1/(magnitude of gradient) and a negative gradient.

WPH02_01_Q11

Some candidates did not convert the diameter into a radius, arriving at an incorrect value for the cross-sectional area. Such candidates were still able to score one mark for correctly using their value for A in the resistivity formula.

WPH02_01_Q12a

This question could be answered in terms of one plane or one direction. Beware, however, of mixing the two marking schemes. When writing about the oscillations being in a single plane many candidates seemed uncomfortable with the idea that the plane contains the direction of the energy transfer. Commonly candidates would score only one mark by writing about oscillations in a single plane but then continuing with the direction of propagation being perpendicular which is only correct when writing about the direction of the oscillations.
Learn what is meant by polarisation in terms of direction or planes.

WPH02_01_Q12b

Candidates needed to realise from the description in the question that the light coming from the screen must be polarised. They then needed to give a description of the two situations with the screen in landscape and in portrait, comparing the orientation of the polarised light to the filters in the sunglasses. Many candidates were able to score three marks but to score full marks there needed to be a use of the word 'component'. Simply saying that the screen becomes darker gives no more information than in the question. Beware of using the pronoun 'it'. The noun that 'it' is referring to may not be clear to the examiner.

WPH02_01_Q13

This is a QWC question where the answer must be clear and organised in a logical manner. In fact, in answering this question there is a natural sequence of events which could help candidates in writing a good answer. The main idea to start with here is that electrons/atoms exist in discrete energy levels. They do not need to understand why a high potential difference gives the electrons energy but from their knowledge of line spectra should know that they do gain energy and as a result move up energy levels. When referring to the electron moving back down there needed to be a mention of a photon.
Equations are a good way to justify what you are saying. However, credit is unlikely to be given for writing down an equation that is given in the list of formulae at the back of the exam paper unless you state the meaning of the terms or refer to it in your explanation.

WPH02_01_Q14a

Candidates needed to appreciate that the plate will become positively charged if it loses negatively charged electrons. The condition for this to happen is that the electrons on the plate gain energy greater than the work function of zinc which will be the case if the frequency of the incident photons is greater than the threshold frequency. A common mistake is to confuse threshold frequency and work function. One is a frequency and the other is an energy linked through E=hf. Make sure you are clear on the difference between threshold frequency and work function.

WPH02_01_Q14b

Candidates firstly needed to appreciate that for a greater intensity of UV the rate at which photons are incident on the plate increases. This affects the rate of the emission of electrons due to the one-to-one interaction of photons to electrons.
Examiner Comment
This candidate has stated the one-to-one interaction between photons and electrons and so scores 1 mark. There must be a reference to the number of photons in a certain time. Simply stating that there are 'more photons' is insufficient. The expression 'the rate of incident photons' can also be expressed as 'the number of incident photons per unit time'. Choose the expression you are most comfortable with and use it where applicable.

WPH02_01_Q14c

The danger here is that candidates could be too vague with their answer. A vague answer 'causes cancer' or 'is harmful' offers no specifics of where or how and is insufficient. Acceptable answers included absorbed by cells, damaging to cells/eyes, causes skin cancer. A reasonable safety precaution would also gain merit such as wearing sunglasses with a UV filter. Candidates using 'hurts' or 'harmful' tended not to score.

WPH02_01_Q15

(a) Candidates could either use V=IR to calculate each resistance, recognising that the current 0.9A would split 2:1 between the two resistances. Or they could use V=IR with the resistors in parallel formula. This second method is lengthier and not so often seen.
(b) This required the use of the sum the answers from part (a) as R in V=IR.
(c) This question as a whole was generally well answered and candidates were able to refer to an equation for power to justify their explanation.

WPH02_01_Q16a

Candidates did, in general cope well with this calculation. Sometimes a mark was lost due a power of ten error, or for forgetting to convert from eV to J.

WPH02_01_Q16b

A multi-step calculation. Firstly the energy stored in the battery during the day needed to be calculated, not forgetting the efficiency. Knowing the power of the bulb then enables a calculation using the power formula to determine the length of time that the LED can be operated. The value for efficiency is given in the question because it is meant to be used. Check that you have used all the data given.

WPH02_01_Q17ai

This pulse-echo question required candidates to use s=d/t with a factor of two. This could be shown by either dividing the total time by 2 or multiplying the distance by 2. They also needed to read the time between the transmitted and reflected pulses from the oscilloscope grid, by multiplying 0.02 ms by a value ranging from between 3.5 and 4. A common mistake was to misread the grid and multiply 0.02 ms by 5.

WPH02_01_Q17aii

For two marks, candidates need to appreciate two things:
Firstly, that there is a reduction in energy due to the distance travelled through the body. The greater the distance the greater the reduction in energy.
Secondly, that reflection also causes a reduction in energy.

WPH02_01_Q17b

Using Doppler the frequency of both the emitted and received pulses are measured in order to obtain the difference between them. This was expressed in a number of ways.

WPH02_01_Q18b

The angle theta labelled in the diagram is not the angle of incidence but will be a maximum value in the critical case. If the angle theta is greater than 90°C (critical angle) then the light will not undergo total internal reflection and there will not be a maximum transfer of energy along the fibre. Therefore a calculation of the critical angle leads to a value of theta. In the critical case the angle of refraction is 90 degrees.
Using: refractive index for light travelling from core to cladding = sin(i) / sin (r) with r = 90 degrees gives i = critical angle.
Candidates then needed to remember to subtract this value from 90.

WPH02_01_Q18c

The information given in the first line under the graph is the key to answering this question. Establishing from the graph, that a laser pulse has a smaller range of wavelengths, it can then be concluded from the information in the question that it must also have a smaller variation in speed as it travels down the fibre. This means that it arrives at the end less spread out giving a sharper signal.

WPH02_01_Q19a

Candidates were required to state that it is a longitudinal wave, the air molecules vibrate and give the direction of the oscillations with respect to the direction of the wave motion.
Learn the definitions for transverse and longitudinal waves. Your description needs to include what is vibrating and the direction of the vibrations relative to the direction that the wave is propagating. Depending on the question you need to be prepared to apply this to a given situation.

WPH02_01_Q19bi

Candidates were expected to recognise this as an interference pattern. To answer the question they needed to explain how the constructive and destructive interference occurs in the water in terms of the path or phase difference between the two coherent waves.
Beware of writing superimposition as opposed to the correct superposition.

WPH02_01_Q19bii

A lower frequency has a longer wavelength. The idea here is that the distance observed between the wavefronts would be greater.

WPH02_01_Q19c

This question required candidates to apply what they know about standing waves in a practical situation. It was not expected that they had necessarily carried out this practical but a wide range of experience with practical situations is always helpful. All the information that is needed to answer the question is given.
(i) They are told that there is a node at the surface of the water and an antinode at the top of the tube. From this, and knowledge of standing waves, it can be established that the length of the tube above the water is equal to a quarter of a wavelength. Drawing this on the diagram may have helped. Therefore 31.8 multiplied by 4 gives the wavelength. The speed of the wave is given in the question so use of this equation enables the frequency to be calculated.
(ii) As previous knowledge of this practical is not assumed a range of reasonable suggestions could be accepted. The answer had to be in terms of the calculated frequency being greater than the actual frequency.

WPH02_01_Q20ai

This is assessing a candidate's ability to criticise some data. The value for the resistance of the leads is very much smaller than the smallest measurement for the resistance of the thermistor and so the error is insignificant. Alternatively it can be seen as a systematic error that affects all measurements by the same amount and so can be subtracted from each reading.

WPH02_01_Q20aii

The reason for using data loggers is that they can do something that a human cannot. It is not about making things easier.
Plotting a graph is not accepted because this is something that can be done without the data logger. The answer should also reflect the context of the question. So, in this case, the fact that a data logger can take readings over a long period of time is not relevant since the water will only take minutes to cool.

WPH02_01_Q20bi

The most straight forward mark to gain here is to start with stating what the obtained results show about the resistance as temperature changes.
The thermistor is a semiconductor device. Candidates need to describe what happens to the number of charge carriers as the temperature increases and to justify their response with reference to the transport equation $I = nAvq$.

WPH02_01_Q20bii

This question required a potential divider calculation that was generally well managed. Most correct calculations used the ratio of the potential differences across the two resistances being equal to the ratio of the two resistances. An alternative method used $V = IR$ *to* calculate the current in the thermistor.
If you have been provided with a graph or asked to draw one then use it, if applicable. Estimating interim readings from a table of results is not good practise - that is what a graph is for. Look at the scales on the x and y axes carefully.

Paper 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. Whilst a sound knowledge of the subject was evident for many, sometimes candidates struggled to find the language to use in order to write precise and unambiguous answers. This will have prevented marks being awarded.
Based on their performance on this paper, candidates are offered the following advice:

- More practise of a wider range of questions, especially longer written questions. Calculations were generally carried out well but candidates did not perform as well in the written answers.
- Learn basic definitions and be prepared to apply them in the context of a question.
- Look at the number of marks available for the question and ensure you include a sufficient number of different points in your answer. Remember that you gain no credit for simply repeating the question.

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