Examiners' Report

Principal Examiner Feedback

Summer 2023

Pearson Edexcel GCE

In Physics (8PH0)

Paper 02 Core Physics II

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Introduction

This paper assessed topic 4, Materials, and topic 5, Waves and Particle Nature of Light. The paper provided candidates with the opportunity to demonstrate progression from GCSE and consolidate their knowledge at the end of the first year of the AL qualification.

Section A, a total of 57 marks, consisted of 8 multiple-choice questions and questions of differing style and length, drawing on a range of different concepts. Section B, a total of 23 marks, consisted of two synoptic questions drawing on content from the whole of the AS specification.

Practical skills and knowledge of aspects of each of the core practicals were assessed throughout. Application of practical skills was also assessed in other familiar or unfamiliar contexts.

Q9(a)

A calculation on pulse-echo technique. Candidates needed to remember that the pulse has to travel there and back. The distance travelled needs to be doubled (or the time halved) to make the distance and time consistent with each other. Candidates were largely able to use a correct factor of two, although this does continue to be a main cause of error.

Q9(b)

This part of the question proved to be more of a challenge. Many candidates fell back on the familiar response as required in past papers "so that the reflected pulse returns before the next pulse is transmitted". However, this was not relevant to this situation as the bat is closer to the moth, so the pulse returns in a short time. The bat can emit a large number of pulses every second so that it is able to detect small changes in the location of the moth. The time between pulses needs to be longer when further away to allow time for the reflected pulses to return. Candidates should be careful with the language and avoid referring to quicker / faster when referring to time.

Q10(a)

Candidates were able to recall the units for each of the quantities in the equation, but their response was not well laid out from that point. This is a 'show that' question and so clear evidence was needed that they knew the SI base units for the pascal from N m^{-2}. Many, having substituted and rearranged the SI base units into the equation, then declared, without justification, that their answer was equivalent to a Pa s.

Q10(b)(i)

Most candidates remembered to find the gradient of the straight part of the graph using a large triangle. However, the power of ten as labelled on the y-axis was then overlooked.

Q10(b)(ii)

Most candidates were able to pick up some marks, with the most common answer being that the fibres stretched irreversibly. The question referred to the point up to breaking point and not just the linear part of the graph. It is good practise, when using graphs, to use the values on the axes to support the answer, in this case by stating the value of the breaking stress or strain.

Q11(a)

Candidates are required to be familiar with a demonstration of the photoelectric effect and to explain the observations made. Candidates often had the correct idea, but responses were muddled. There needs to be a link made between frequency and energy with reference to a photon. One electron absorbs one photon. The energy of a photon is dependent on the frequency of the radiation. If the frequency is below the threshold frequency, then the photon contains insufficient energy to emit an electron. Many candidates quoted the meaning of threshold frequency but failed to relate it to the situation.

Q11(b)

Both calculations were tackled well with over half of candidates scoring full marks.

(b)(i) The most straight forward way to determine the maximum velocity is to read E_{max} from the graph and then apply the kinetic energy equation.

(b)(ii) The work function can be determined either by extrapolating the graph to find the y-intercept, or, by calculation using the threshold frequency. As a deduce question the answer needs to be converted onto eV so a comparison could be made. A few candidates converted all the eV values in the table into J. This is a valid, but lengthier, method.

Q12(a)

Most candidates were aware of the change to the number of nodes and antinodes for 1 mark. The question asked about the *gradual* increase in the frequency to 2*f* and many candidates failed to mention the observation between *f* and 2*f*. There would be a reduced amplitude until 2*f* is reached.

Q12(b)

Some candidates described a longitudinal wave, overlooking the emphasis on pressure variations. There needed to be the idea of molecules moving closer together or further apart to create areas of high and low pressure. Compressions and rarefactions were commonly referred to, but with no detail of the motion/displacement of the molecules in each case.

Q12(c)

Around 25% of candidates scored full marks. Most candidates equated the two equations correctly, but some did not realise the wavelength is twice the length when there is one antinode on the string – the fundamental frequency. The more common route, thereafter, was the calculation of the minimum and maximum frequencies that can be obtained on this string, followed by a comparison to 196 Hz. Alternatively they could calculate the length of the string and compare with the range given in the question. Candidates remembered to add a conclusion although in this case they needed to refer to the range in values, in either frequency or length.

Q13(a)

Whilst many candidates seemed confident with the path of the rays, marks were limited by inaccurate drawing and/or failing to correctly add the image on to the diagram. The best outcomes were achieved when candidates used a sharp pencil and ruler.

Q13(b)

A challenging multistep calculation.

Interpretating the information given in the question: required image height = 0.1 mm, object height = 10 μm, object distance = 0.012 m. There are several approaches to the problem:

1. Calculate both the required and the actual magnification of the image with a comparison.

2. Calculate both the required and the actual image size with a comparison.

3. Calculate both the required and the actual power of the lens with a comparison.

Marks were gained for the use of equations, but many candidates entirely missed the need to compare what was required with what was actually happening in terms of either the magnification, image size or power and so used equations without really knowing where they were going with the answer. Some candidates did not distinguish between the object/image distance and the object/image size.

Q13(c)

The path of the ray in the diagram is showing total internal reflection, so candidates needed to deduce whether or not the ray was reflected, or refracted at X. This can be done by either calculating the critical angle and comparing with the incident angle, or attempting to calculate a refractive angle. The majority of candidates calculated the critical angle. Confusion between the incident angle and the critical angle when making a conclusion was regularly seen.

Q14(a)

Over 40% of candidates scored full marks across both (i) and (ii).

(a)(i) Upthrust is the weight of the displaced water. The equation for the volume of a sphere needs to be recalled and substituted into the density equation $\rho = \frac{m}{V}$ to determine the mass of the displaced water. The mass then needs to be converted into weight by multiplying by *g*. Some candidates recalled the equation for the volume of a sphere but then, having written r^3, forgot to cube the radius in their calculation. Incorrect rounding to 1.72 was also commonly seen.

(a)(ii) Use Stoke's law $F = 6\pi r\eta v$ to determine *v.* This was calculated successfully overall.

Q14(b)

Nearly 50% of candidates failed to score on this question. The main loss of marks was failing to correctly substitute the Hookes's law equation into the equation for the elastic strain energy.

Section B

Q15(a)

This was a question on how standing waves are produced, a familiar question based within an unfamiliar context. Many failed to state that there is a constant phase relationship between the two beams, but candidates were reasonably confident at describing the formation of nodes and antinodes. Marks were not awarded mainly by omissions rather than errors.

Q15(b)

Candidates were expected to apply their knowledge of standing waves and diffraction gratings in this unfamiliar context. The standing wave created by the lasers is acting like a diffraction grating with the nodes behaving as the gaps, as stated in the passage. For a standing wave the distance between adjacent nodes is numerically equal to half the wavelength, so, in this case, $d = \frac{532 \text{ nm}}{2}$. It was pleasing to see less confusion between *n* and *d* than seen in previous years, but some could not calculate the angle using tan.

Q15(c)

A common misconception was that as the electron is a particle it does not diffract. For those who realised this was electron diffraction, some did not appreciate the very large difference in scale between the wavelength of an electron and the width of the gaps.

Q15(d)*

Lots of time and answer space was wasted by referring to how an electron gets excited rather than using an excited electron as the starting point which the question gives them. Many candidates frequently were referring to atoms without mentioning electrons at all and some confused this process with the photoelectric effect referring to threshold frequency, work function and emission of electrons (a misunderstanding also evident in Q11(a)). As an electron de-excites it falls back down through fixed energy levels, so the emitted photon has a limited range of wavelengths and frequencies. A lot of candidates missed the point that the focus was on energy to lead them to the idea of discrete wavelengths particularly missing the point that only certain energy level transitions are possible.

Q16(a)

The potential difference–current characteristics for a light bulb has been assessed previously on both this paper and 8PH01. Most candidates started off well with recognising the relationship between V and I from the graph although then went on to, incorrectly, state that current decreases. As the p.d. increases, the *increase* in the current gets smaller, but the current does not decrease. Many realised that the resistance increases but were unable to explain this in terms of the increase in temperature. As the temperature increases there is an increase in the amplitude of the lattice vibrations, and an increase in the frequency of collisions between the electrons and the ions.

Q16(b)

Candidate responses revealed a weak understanding of making measurements in electrical circuits. Suggestions made included incorrectly moving the ammeter to the other side of the power supply, or swapping the ammeter and voltmeter. Only MP1, the use of a variable resistor, was regularly achieved, although it was not clear that candidates understood why this would be a good idea. It had been hoped that candidates would use the detail given in the question and compare to the characteristics shown: for example, use of mA instead of A, smaller range in potential difference, 0 to 0.6 V instead of 0 to 12 V.

Summary

Based on their performance on this paper, students should:

- Use different contexts in which to explain physics concepts and ideas.
- Consider the correct language and keywords to use in written answers.
- Revise the photoelectric effect and possible demonstrations, as distinct from electron energy levels within an atom.
- Practice investigations involving electrical circuits and measurements of current and voltage.

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