Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel GCE
In Physic (9PH0)
Paper 2: Advanced Physics II

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9PH02 2010 PE Report

This was the third sitting of this examination for the new specification. The assessment structure of Advanced Paper 2 is the same as that of Paper 1, consisting of ten multiple choice questions and a number of short answer questions followed by longer, structured questions based on contexts of varying familiarity.

This specification has introduced two new question styles which were represented in this paper. Questions 17(a) assessed the ability to structure answers logically while Assessment Objective 3 (AO3) was represented by questions 11, 13(b), 17(a) and 17(b). Of these, question 17(a) required the evaluation of scientific information, ideas and evidence and the other AO3 questions required a deduction or judgement with justification of the conclusion. Students generally responded well to these, showing some ingenuity in the variety of approaches, although the conclusions were not always made with sufficiently explicit comparisons for the numerical questions and so the final mark was not always awarded.

This paper allowed students of all abilities to demonstrate their knowledge and understanding of Physics by applying them to a range of contexts with differing levels of familiarity.
Students at the lower end of the range could complete calculations involving simple substitution and limited rearrangement, including structured series of calculations, but could not always tackle calculations involving several steps or other complications, such as applying correct temperature differences or using lines per millimetre in a diffraction grating to calculate slit separation in metres. They also knew some significant points in explanations linked to standard situations, such as the formation of stationary waves and the photoelectric effect, but frequently missed important details and did not always set out their ideas in a logical sequence, sometimes just quoting as many key points as they could remember without particular reference to the context. Overall they scored much more highly on Assessment Objective 1 than on Assessment Objectives 2 and 3. Steady improvement was demonstrated in all of these areas through the range of increasing ability and at the higher end all calculations were completed faultlessly and most points were included in ordered explanations of the situations in the questions.

Question 11

Most students made a good start to the question, applying the formula $\Delta Q = mc\Delta\theta$, but identifying the correct temperature change proved troublesome to many. While the straightforward way to deduce whether the temperature would be within the required range was to calculate the final temperature of the drink, some students attempted alternative approaches, such as calculating the mass of one of the liquids that would ensure a temperature at one end of the range or comparing the required energy transfer with the actual energy transfer, but they rarely linked their results to an adequate conclusion.

Question 12

(a) While this question proved straightforward to most students, a number stumbled on the trigonometry and did not apply $s - t$ but only one of these and therefore used an incorrect angle in their calculations.

(b) Students rarely failed to arrive at the correct value for the speed of light even if they had a problem in part (a) because a 'show that' value was provided for refractive index. For this question in particular, however, a surprisingly large number of students omitted the unit from their answer and so failed to be awarded the second mark.

Question 13

(a) Most students demonstrated familiarity with the definition of simple harmonic motion, but rarely applied it fully to the context of the mass on the metal strip, merely quoting a version. Students were more likely to be awarded the second mark, many just stating 'displacement' rather than 'displacement from the equilibrium position' as required. Some clearly thought that the graph applied to vibration of the mass and gave definitions in terms of the deviation.

(b) Given the suggestion to treat the system in he same way as a mass on a spring, students generally identified the relevant formula and knew that they would need to use the graph to determine *k*. This was done with varying degrees of accuracy. Students then attempted the question using the suggested frequency to determine the corresponding mass or used 50 g to determine the corresponding frequency. Having done so, however, few students made an explicit comparison to data in the question and gave a satisfactory conclusion.

Question 14

(a) Students were usually able to apply the Stefan-Boltzmann law with the electrical power formula, but very often applied the percentage in the reverse fashion and so did not arrive at the correct final answer.

(b) (i) Students generally had an idea of the correct curve but did not always use the data to calculate the wavelength for maximum radiated power. The most common errors on the graphs seen were having a positive y-axis intercept and showing zero power at the longest wavelengths.

(ii) Most students were able to describe the majority of the radiation being in the non-visible part of the spectrum, but they did not often relate this to efficiency by referring to useful output.

Question 15

(a) The first two marks were awarded very frequently, but students did not often include sufficient detail for the award of the third mark, where they were required to refer to the phase relationship, the nature of the interference and an outcome. Some students referred to maximum displacement instead of amplitude.

(b) Most students correctly stated the wavelength and they could usually then apply it correctly to determine the frequency.

(c) (i) Despite this calculation requiring several steps, it was not troubling for most students. The most common error was reversing the numerator and denominator in the stress formula to arrive at a very large extension they should have realised was impossible.

(ii) Answers were given in terms of both tension and mass per unit length, but students did not always justify these with reference to the formula for wave speed. Similarly, the final conclusion frequently did not contain reference to the unchanged wavelength.

Question 16

(a) (i) While most students arrived at the correct answers, some students started by assigning the change in atomic number to the emission of 5 alpha particles and then thought that the resulting difference in mass of 12 was due to that many beta particles.
(ii) The great majority could calculate the decay constant, although some effectively wasted time by converting unnecessarily to seconds, and they used it in the decay formula. Frequently, however, they used 50 as the final number rather than 53.

(b) The concept of gravitational potential was not generally well applied. Many candidates calculated the potential energy at the surface of the Earth but they did not always realise its significance or know how to proceed further. Some attempted to apply the formulae for gravitational force or gravitational field strength, sometimes assuming the value of *g* remained constant at all altitudes. The unit km was not always converted to m.

(c) This was generally approached well, many candidates recalling the orbital formula, although this is not recommended because an error in reproducing the formula will result in no marks being rewarded for further working. The answers were divided between those using speed and those using angular velocity, some completing calculations at eah stage but many making a full combination before substitution. The most common error in the calculation was not applying the correct power to the radius in the calculation; this could be square or cube depending on the method adopted.

Question 17

(a) At the lower end of the ability range students were prone to confusing the photoelectric effect with photon emission and absorption in spectrum formation, but most demonstrated some knowledge and understanding of the stated phenomenon. The observations and models were not always adequately linked. The most common observation stated was related to threshold frequency, usually linked to the photon model. Students did not always identify that the increased rate of emission with increasing frequently might be explained with a wave model.

(b) Most students knew they had to use a gradient and used the graph in its determination, but some did not inspect the x-axis fully and took the highest value of frequency as the change in frequency they were using for the gradient. After calculating the value of the Planck constant from the graph many students were not able to make th required comparison in terms of percentages.

(c) Most students could apply the formulae to arrive at an energy in eV but they could sometimes fail to identify the correct level.

(d) Large numbers of students used the number of lines per millimetre, possibly converted to lines per metre, as the actual slit separation and were therefore unable to obtain any marks. They should have realised there was an error from the extremely small angle this produces as the answer.

Question 18

(a) The majority were well prepared for this calculation and proceeded with ease.
(b) Candidates were clearly familiar with the conditions for sustained fusion, but they did not always explain them in sufficient detail. It was much more likely to see a response which correctly explained the need for high temperatures than the requirement for very high density, with students failing to include close proximity or collision rate as part of an explanation.
(c) (i) As seen in previous series, students often experienced difficulty with relating the mass of the sample, the mass of a molecule and the number of molecules, which meant that they could not arrive at a correct value. A significant number also had problems with the unit mg.
(ii) In this part of the question the mass of the sample was often used instead of the mass of a molecule. The final step of calculating the square root of the mean square speed was also omitted quite frequently.
(iii) While students could usually calculate the wavelength shift and add it to the original wavelength, they often omitted the step of doubling the wavelength shift specified for this context. Those who read the question fully were able to avoid this error.

Paper Summary

Based on their performance on this paper, students are offered the following advice:

- Where you are asked to come to a conclusion by command words such as ‘determine whether’ or ‘deduce whether’ using numerical data, you must complete your calculations, then explicitly compare the relevant values and then make a clear statement in conclusion – ‘Calculate, Compare, Conclude’.
- Check that quantitative answers represent sensible values and to go back over calculations when they do not.
- Learn standard descriptions of physical processes, such as the production of standing waves or the requirements for fusion, and be able apply them with sufficient detail to specific situations, identifying the parts of the general explanation required to answer the particular question in a given context.
- In questions with mixed quantities, be sure to convert all values to standard SI base units or derived units, such as mg to kg.
- Be sure to know the standard SI prefixes and be able to apply the correct power of ten
- Physical quantities have a magnitude and a unit and both must be given in answers to numerical questions.
- When substituting in an equation with a power term, e.g. r^2, don’t suddenly miss off the index when substituting or forget it in the calculation, such as by failing to calculate a square root.