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International AS and A-level

Physics (9630)
PH02 Electricity, waves and particles
Report on the examination

June 2024

REPORT ON EXAMINATION: INTERNATIONAL AS PHYSICS (9630) PH02 JUNE 2024

This paper was found to be of a similar demand to the previous series, with a slight increase in the mean and standard deviation.

As in most previous series, students performed better on average in the multiple-choice section than in Sections A and B. In Sections A and B, students performed best in the one-step and two-step calculation questions (such as 1, 2 and 8.2), and also did well when taking data from a graph (4, 8.5).

Students performed less well in description and explanation type questions (such as 3, 5.2), particularly those which required an interpretation of the context, such as 7.1 and 7.2. Another area of weakness, as in previous series, was commenting on experiments, such as in 11.4.

In terms of topic areas, the cohort performed slightly better in specification area 3.4 Electricity than 3.5 Oscillations and Waves.

Some general principles to note that apply in every series:

- An '*Explain*' question relating to a context-based question usually requires a comment on the context in the answer. For an example in this paper, see the commentary for 7.1 below.
- When a gradient is determined from a graph, the points chosen must be clearly marked on the graph (eg by drawing a triangle) and must be further apart than half the range of the data. The example in this paper is 7.4.
- When direct measurements from a diagram are required, for example with a ruler or protractor, the student must make clear (usually on the diagram) what their measurements were. See 9.2 in this paper.

SECTION A

QUESTION 01

This question was generally well answered, with almost two-thirds of students scoring full marks. The most common error was confusing time period and frequency with the information given.

QUESTION 02

This was also well answered, with almost two-thirds of students scoring full marks. Some students did the unit conversion incorrectly.

QUESTION 03

Students found this explanation one of the hardest in section A. Some students did not relate the voltage terms to energy.

QUESTION 04

This question was well answered, with almost three-quarters of the cohort scoring full marks. The commonest error seen was the conversion of mA to A.

QUESTION 05

Students did well in 05.1, relating a physical circuit to a circuit diagram.

They did less well in 05.2, explaining the outcome of removing a cell from a circuit. Only around a quarter of students scored any marks here. A common error was assuming that the emf and internal resistance add in parallel. The students who did score marks mostly understood that the emf would stay the same, and the internal resistance would increase.

05.3 was better answered, with over half of students scoring the full three marks. Again a common error was not combining resistance in parallel correctly.

QUESTION 06

06.1 was generally well answered, with around two-thirds scoring at least one of the two marks. Most students could describe the meaning of excitation. Some students were not clear in their distinction between a free electron and an electron that is part of the atom. Good, clear responses described the free electron interacting with the sodium atom rather than electrons within it. Some incorrectly stated that the free electron's kinetic energy must be exactly equal to (instead of exceeding) the difference between energy levels, but this error was condoned on this occasion as it was not the main object of the question.

06.2 had a good range of responses. Most students scored at least one mark. Generally students stated that energy levels in the atom are discrete. Many also described excitation leading to photon emission. Fewer students stated clearly that the photon energy is equal to the difference between two energy levels; some incorrectly stated that the photon energy is equal to the atomic energy level itself.

06.3 This was well answered, with most students scoring at least two out of the three marks. A common error was using the difference of two wavelengths instead of the wavelength itself.

QUESTION 07

Students found Question 7 difficult.

Around a fifth of students scored the mark in 07.1. Many students stated that the driving frequency must match the natural frequency, but did not refer to the context itself so this was not sufficient for the mark. Others incorrectly thought that the water was resonating, rather than the air in the tube.

In 07.2, around 42% of students scored one mark, identifying the maximum amplitude and stationary particles. Very few students correctly stated the direction of oscillation. Some used the word '*displacement*' instead of '*amplitude*'.

Around half of students scored the mark for algebraic manipulation in 07.3. Some did not choose the correct equations to use, instead using the equation for a stationary wave on a string.

Around half of the students scored at least two of the three marks in 07.4. Most knew to use the gradient but some did not choose points far enough apart on the graph. We require a clear

annotation of which points are chosen for a gradient determination; the points chosen must be at least half the range of data apart.

Around half of students scored one mark in 07.5, identifying which intercept should be used and how. Very few spotted the false origin and correctly explained that extrapolation must be done mathematically.

QUESTION 08

Question 8 gave a good spread of responses generally and differentiated well between students.

Around a quarter scored full marks in 08.1, giving a good explanation of modal dispersion.

Nearly all students calculated the refractive index correctly in 08.2.

Almost half scored full marks in 08.3. Many clearly knew what to do but did not '*show*' their answer correctly. In a 'show that' question we need to see clear algebra leading to the answer, and an extra significant figure in the numerical answer.

Around half of students scored the mark in 08.4. Some used sine or tangent instead of cosine.

Over half of students scored full marks in 08.5; some used an incorrect time period, eg pulse duration, instead of the period of repetition.

Very few scored full marks in 08.6; many did read off the pulse duration but did not add the time delay.

Only around a fifth of students answered 08.7 correctly. However, of those, there were some very well explained answers about broadened pulses overlapping.

QUESTION 09

Students found question 9 the hardest overall in the paper.

Around a third got the mark in 09.1, usually with the alternative response in the mark scheme.

09.2 yielded a good spread of responses. Around half scored at least one mark, usually by measuring the scale line and using that measurement. Very few scored the full four marks. Some students did not take any direct measurements at all, instead estimating by eye that the scale line was approximately equal to 4.5 fringe widths: these students were limited to one mark (marking point 3). Some did take direct measurements but only of a single fringe width, which is poor practical technique.

Around a third of students scored full marks in 09.3. An equal number left it blank, perhaps after finding 09.2 difficult. Some students incorrectly used the equation for the energy of a photon.

SECTION B

QUESTION 10

Students did well in this question overall.

Nearly all scored the mark in 10.1.

Around half scored at least one mark in 10.2, many stating that the copper wire would overheat if its resistance were too high. Some confused the power dissipated in the nichrome as '*wasted*'. A large minority said that copper either '*allowed*' or did not allow the current to '*reach*' the nichrome. In reality the current drawn in series is dependent on the total resistance of both metals.

Around three-quarters scored full marks in 10.3. A common error was halving the radius, as if it is diameter.

10.4 differentiated well. Nearly 40% of students scored at least one mark, usually by correctly stating that resistance increases as temperature increases. Very few scored all three marks. Some students incorrectly treated the filament as a thermistor.

QUESTION 11

Question 11, the practical question, was slightly better answered than in previous series.

Nearly all answered 11.1 correctly.

Around half calculated the percentage uncertainty correctly in 11.2.

Most students scored at least one mark in 11.3; some did not use the tangent of the angle correctly to determine the angle, instead using sine. Some used the double-slit equation, which is incorrect here.

11.4 was poorly answered, with only around 1 in 10 students scoring both marks. Some students incorrectly suggested that the wavelength itself might change as a result of changing the grating, which shows a lack of understanding of the experiment.

SECTION C

The best-answered questions were:

- 15, a qualitative potential-divider question
- 19, interpreting oscillation graphs
- 23, a Snell's Law calculation

The worst-answered questions were:

- 14, about current as a rate of flow of charge. B was a popular distractor, for candidates who did not add the ion and electron currents.
- 16, a percentage uncertainty question. B was a popular distractor.
- 22, a diffraction-grating question. Both A and B were popular distractors.
- 24, a photon-energy question. Both B and C were popular distractors.