OXFORD
INTERNATIONAL AQA EXAMINATIONS

INTERNATIONAL AS LEVEL
PHYSICS

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

January 2021

REPORT ON EXAMINATION: INTERNATIONAL AS LEVEL PHYSICS 9630 PH02 – Electricity, waves and particles – JANUARY 2021

General comments

This paper contained a variety of question styles that provided students with many opportunities to demonstrate their knowledge and understanding on a range of topics. Mathematical questions were often answered very well. Students had more difficulty with questions with extended writing that required the use of precise scientific language. Unclear and ambiguous answers were not rewarded.
Questions assessing AO2 and the data analysis aspects of AO3 were usually answered well. Questions assessing AO1 and the evaluation aspects of AO3 were more of a challenge as they often required answers that used precise and correct terminology. Questions assessing AO4 were answered well by students familiar with the context.

Section A

QUESTION 01

1.1

Most students who answered this correctly referred to the equation in words. It is important when defining quantities, such as resistivity, that answers are precise. The mark was lost by those who only referred to the area rather than the cross-sectional area, for example.

1.2

This straightforward calculation was done correctly by the majority of students. A relatively common error was using diameter rather than radius or using the wrong equation for the cross-sectional area.

QUESTION 02

This question produced a range of marks and discriminated well. Students who did not achieve full marks often included ‘constant phase difference’ in their description, indicating confusion with coherence. Another common omission was a failure to make it clear that the situation involves two waves travelling in opposite directions.

QUESTION 03

3.1

Very few students were able to gain both marks for this question. The best answers showed that the central maximum was twice the width of the subsequent maxima. They also showed a significant decrease in the height of the maxima moving out from the centre of the pattern. The shape of the pattern proved to be challenging for many students.

3.2

It was clear in the question that M had to be placed on the left on the position axis. Many students, who may have known that the pattern was narrower, placed M incorrectly on the right of, or off, the axis.

3.3

Surprisingly few students realised that a wider slit would increase the intensity of the maxima.

QUESTION 04

4.1

This straightforward calculation was answered well by the majority of students.

4.2

This proved to be much more challenging than 4.1. A common error was to use the whole circuit resistance, or the emf, in the calculation. When the final answer was incorrect, in some circumstances a mark was available for the first step of a power calculation. It is important that students set out their answers clearly so that compensatory marks of this kind can be awarded.

QUESTION 05

5.1

Most students performed this calculation correctly and expressed their answer to a sufficient number of significant figures to get the mark.

5.2

This question was answered correctly by the majority of students and discriminated well. The best answers were structured to make it clear how Einstein's equation was used, and the energy unit conversions were explicit.

5.3

This question also discriminated well. The best answers had lines that were clearly parallel and were labelled. Some answers also made a good attempt to separate the intercepts to represent the work functions.

5.4

Most students realised that the stopping potential would be lower, but many could not justify it clearly. There was some evidence of confusion between stopping potential and work function.

QUESTION 06

6.1

Questions about the characteristic for a diode have been asked in the past. Students are expected to be familiar with the detail of the graph. However, many careless answers were seen and only the best answers were given this mark.

6.2 and 6.3

Students should be advised to take care when drawing circuit diagrams in examinations. Most students were familiar with the circuit symbols required, but many fewer were able to draw the required circuits. The circuit diagram using the potential divider proved to be particularly challenging.

6.4

Answers to this question suggested that many students were not familiar with the use of a potential divider. Several answers referred to reducing the resistance to zero, without any mention of the effect on the range of potential differences available.

QUESTION 07

7.1

This four-mark multi-step question was well answered by the majority of students. The best answers set out the work clearly, referencing the resistances and current value and expressing the equation using symbols before making the substitutions. It is important to make every step of a ‘show that’ answer clear to obtain full marks.

7.2 and 7.3

The majority of students were able to apply their knowledge and understanding of the circuit to work out the resistance and the power.

7.4 and 7.5

These questions demonstrate the need for students to apply their knowledge and understanding in qualitative terms. This proved to be much more challenging than the calculations in the previous question parts. Electrical problems of this kind follow a logical sequence that examiners look for when marking. Many of the answers to these two questions were confused and contradictory which meant that full marks were rarely awarded.

QUESTION 08

8.1

Most students were able to recall that coherent sources have the same frequency, but many missed out any mention of the phase relationship, or simply said that the sources were in phase. The best answers made it clear that the sources had a fixed or constant phase relationship.

8.2

A common problem that many students have when discussing interference is to confuse phase difference and path difference. Answers that showed an understanding of the phase relationship for a maximum or minimum intensity were common. However, the idea that moving the mirror introduces a change in the path difference was missed by many students.

8.3

Many students answered this question by dividing the wavelength by 4 and doing little else. This gained no credit. For full marks it had to be clear that, for a minimum, the change in path difference was half the wavelength, and that, because the light reflects, moving the mirror a distance d introduces a path difference of $2d$.

8.4

This question proved to be challenging for the majority of students. The best answers used dotted lines downwards from the diagram to identify the boundaries of light and dark on the grid. They also used the scale to demonstrate that each change in boundary corresponded to a height change of 1.6.

8.5

Many ambiguous answers were seen to this question. The mark was only given if it was clear that the resolution had increased. ‘Smaller’ resolution was not given credit unless it was further explained that ‘smaller’ in this case meant ‘better’.

8.6

This question was generally not answered well. There was much confusion about dispersion, and how the uneven surface led to many different paths was often unclear.

SECTION B

QUESTION 09

9.1

This mark was not awarded unless Figure 12 was annotated correctly. About half of the students managed to do this and obtain an angle within an acceptable range.

9.2 and 9.3

Students are expected to know that a typical uncertainty associated with an instrument reading is half a scale division. They should also know that many measurements involve the difference between two readings, even if one of the readings is zero. This doubles the uncertainty to one scale division. The best answers to these questions demonstrated an understanding of these ideas, but they were rare.

9.4 and 9.5

Any errors in previous parts were carried forward into these two questions which meant that students were not penalised twice. Both questions discriminated very well. A common error in 9.4 was adding the absolute uncertainties rather than the percentage uncertainties. Adding uncertainties was only valid if the two measurements had the same value.

QUESTION 10

10.1

Most of the students who understood what this question was about were able to obtain full marks. The best answers set out each step clearly.

10.2

Students were required to use an equation available to them in the data and formulae booklet. It is not surprising that the majority of students obtained both marks. Students should be aware that the first mark for calculations of this kind is often for the manipulation of the equation to make the desired quantity the subject or for the substitution of the data. When this is not clear, students who make a calculator error are likely to get zero marks.

10.3 and 10.4

These are further examples of questions where students are expected to make a qualitative analysis of a problem. For each question, to obtain any marks, it had to be understood that the added mass was placed above the existing centre of mass. This was often not clear. In the best answers, students explained how the positioning of the mass led to a reduction in the effective length and hence a reduction in the time period.

SECTION C

There were several relatively easy multiple-choice questions including 11, 15, 17, 19 and 21.

The most difficult multiple-choice questions were 12, 18 and 23.

In question 12 all of the options were almost equally popular. It is a common misconception that the resistance of a component is the gradient of its *V*-*I* characteristic. This is only true if *V* and *I* are directly proportional.

The most common answer to question 18 was B. This error was made presumably because students did not spot that the sound from P and Q was initially in antiphase.

In question 23, option D was almost as popular as the correct answer (B). It should be emphasised to students that the photoelectric effect is evidence of the particle nature of light, not the wave nature of electrons.

Although the correct answer (C) was the most common response to question 20, both B and D proved to be popular. Presumably, students who calculated the answer obtained a value close, but not equal, to 45^{o} due to rounding. An algebraic approach would have given the correct answer.

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OXFORD
INTERNATIONAL
AQA EXAMINATIONS

OXFORD INTERNATIONAL AQA EXAMINATIONS
GREAT CLARENDON STREET, OXFORD, OX2 6DP
UNITED KINGDOM

enquiries@oxfordaqaexams.org.uk
oxfordaqaexams.org.uk