OXFORD
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INTERNATIONAL A-LEVEL PHYSICS

(9630) PH04

Report on the examination

January 2024

REPORT ON EXAMINATION: INTERNATIONAL A-LEVEL PHYSICS (9630) PH04 JANUARY 2024

This paper was similar to those of previous years in terms of specification coverage and demand. Students had many opportunities to demonstrate their knowledge, skills and understanding across a range of topics. The usual variety of question styles including short answers, single and multi-step calculations, extended writing and multiple choice were used.

The balance of assessment objectives and the mathematical demand was similar to previous series.

QUESTION 01

Question 01.1 was a relatively straightforward question and most students obtained both marks. Some students only received one mark as they failed to include potential energy in their answer, confusing the system with an ideal gas. A more common problem was a failure to state that the potential and kinetic energies are added to give the internal energy.

The mark scheme for 01.2 allowed the students to obtain at least one mark for combining the work done and the heating in some way. About half of the students obtained both marks for also applying the correct sign convention, obtaining a value of -330 J for ΔU.

QUESTION 02

In 02.1 students were only penalised once for any one error. This meant that the question discriminated very well. The most common errors were**:** squaring the value of the mean square speed, and using the mass of the gas as the molar mass or the mass of one molecule. Students should be encouraged to read the data carefully before substituting them into an equation. Several alternative routes were seen and each was given equal credit, as shown in the mark scheme.

Many more students were able to get full marks in 02.2. This was partly because any error that had been penalised in 02.1 was not penalised again. This is shown by ecf (error carried forward) in the mark scheme.

Many of the students who obtained high marks for the earlier parts of the question were unable to score so well in 02.3. Teachers should be encouraged to train their students to answer explanations of this kind. Only 3% of students obtained full marks. Answers were often too vague or ambiguous or did not approach the question with reference to the kinetic theory model. The best answers made it clear that they were referring to the gas inside the sphere and showed a clear application of the rate of change of momentum of the particles to the situation. The mark scheme allowed a compensatory mark for a statement of Boyle's law and this was the only one obtained by many students.

QUESTION 03

More than half of the students were able to obtain full marks on question 03.1. The mark scheme was designed to reward students who made some progress and it discriminated very well. It was expected that students would work in SI units, but a unit of J g^{-1} was also rewarded when consistent with their answer.

Question 03.2 behaved in a very similar way to 03.1. The best answers were set out clearly so that the substitution into the thermal conductivity equation could be seen. In contrast to previous years, very few answers using Boltzmann's constant for k were seen.

Question 03.3 proved to be much more demanding than the previous parts, with only about 20% of the students getting both marks. Students were expected to use the ratio of the masses of melted ice with heater on and off. Many students attempted to use the latent heat calculated in 03.1, despite having been told that this value was not correct. Answers following this route were limited to one mark.

Question 03.4 was one of the most demanding questions on the paper. It was clear from many answers that students did not take into account that the latent heat was *less than* the accepted value. Other students showed a poor understanding of 'accuracy' and wrote in general terms about precision instead. A high proportion of students did not attempt this question.

QUESTION 04

04.1 was one of the best discriminating questions on the paper. It caused little difficulty for most students, with over 65% getting full marks. A fairly common error was omitting the moment of inertia of the jib.

04.2 also discriminated very well and produced a good spread of marks. The mark scheme rewarded students for each step in the calculation independently. Students who arrived at the wrong answer could still be rewarded with marks provided that their answer was set out sufficiently clearly.

Question 04.3 was a little more demanding than the earlier parts. Students were expected to draw a clear gradient at the steepest part of the graph. The best answers showed a clear mark on their gradient, obtained a value within tolerance, and compared their value with the 0.10 in some way.

04.4 performed in a similar way to 04.3, with about 30% of students getting full marks. Students who did not gain full credit often failed to set out their argument clearly. It was common for the step relating angular displacement to angular acceleration to be omitted, for example.

QUESTION 05

Although the characteristic for a solar cell has been tested several times in the past, this was the first time that students had been asked to sketch the graph and label the axes. Many students had little trouble with the intercepts, but the point of maximum power was often missed. Marks were also lost by students who drew multiple lines or failed to label their axes correctly.

More than 70% of students were able to calculate the light intensity correctly in 05.2. This did not prevent the question from discriminating very well. Common errors included failing to include the efficiency correctly, or at all in some cases.

05.3 also discriminated very well. Just over half of the students obtained full marks. Some students could only obtain partial credit because they confused which cells were in series and which were in parallel. The best answers showed clearly how the number cells across and down the array were calculated.

QUESTION 06

Some misspelling of 'moderator' was tolerated in 06.1. More than 80% of the students were able to give the correct answers for both 06.1 and 06.2.

06.3 was much more challenging. Answers often demonstrated little understanding of the process of induced fission in a thermal reactor, or what is meant by a chain reaction. Fewer than 3% of students obtained both marks.

Students performed much better on 06.4 with over 66% of students getting full marks. It was clear that some students were unsure what was meant by '*three more collisions*'. Partial credit was given for these answers provided it was clear what the student was doing.

Question 06.5 required students to apply their understanding of what happens during collisions to the behaviour of the neutrons. The best answers made it clear that having a target nucleus with a mass closer to that of the neutron would mean that a greater fraction of the energy was lost in each collision. Very few students were able to answer in a clear way, however.

The calculation in 06.6 was completed correctly by more than 80% of the students. Some errors were made by students who used a complicated route to convert values in u into MeV. This is despite the fact that the conversion is given in the Data and Formulae booklet.

QUESTION 07

It was clear from the answers to 07.1 that many students had carried out a similar analysis before. It was rare to see answers obtain both marks, however. As this was a 'show that' question, answers needed to be set out with each step shown clearly. Many students missed out part of the argument or did not state that R_0 was constant, for example.

The calculation in 07.2 was much more accessible, with over 70% of students obtaining all three marks. This question also discriminated very well.

SECTION B

The most accessible section B questions were B9, B18, B13, B19, B8, B17, B14 and B11. These were all answered correctly by more than three-quarters of the students.

The most demanding question was B21. This tested students' knowledge of percentage uncertainty and the gas laws. The most common answer used a percentage error for the temperature based on the value in Celsius rather than kelvin.

In B16, slightly more students chose the incorrect answer A than the correct answer (D).

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