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International AS and A-level

Physics (9630)
PH03 Fields and their consequences
Report on the examination

June 2024

REPORT ON EXAMINATION: INTERNATIONAL A-LEVEL PHYSICS (9630) PH03 JUNE 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 questions were set in a range of both familiar and unfamiliar contexts.

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

QUESTION 01

The question assessed circular motion in the context of a rotating space station. The mathematical parts of the question were answered well, but a failure to understand the context prevented many students from making much progress with the written answers. Students should read the stem of questions carefully to make sure that they understand the situation fully.

Most students only gave a basic answer to question 01.1 and were given one mark. Very few realised that each foot would have its own reaction force, which would be about half of the weight. There were many carelessly drawn and poorly labelled arrows. Students should use a ruler whenever drawing a straight line in the examinations.

Question 01.2 was answered correctly by more than 75% of students. It had to be clear to the examiner that the arrow was passing through the person towards the centre point of the space station. Poorly drawn arrows were not given the mark. Incorrect answers commonly had arrows drawn tangentially or radially outwards.

Question 01.3 was one of the most challenging on the paper. Many students failed to understand the context and insisted on referring to a weight, treating the space station as a rotating circle on Earth. This was despite it being clear in the stem that the space station was in deep space. It was clear that few students had an understanding of the role of the reaction force of the ground when we experience weight. The diagrams in the earlier parts were designed to help students appreciate this but good answers were very rare.

The calculation in 01.4 was much more straightforward. Most students were able to equate the centripetal acceleration to g, and therefore determine the mass.

Question 01.5 discriminated well, but was very demanding. The mark scheme was designed to reward some knowledge so that about 37% obtained at least one mark. The best answers showed a realisation that the centripetal force on the ball was provided by the hands of the person and that releasing the ball would mean it no longer travelled in a circle. They then used Newton's first law to explain that, in the absence of any force on the ball, it would move in a straight line at a constant velocity to the right. The most common error was to suggest that gravity would pull the ball down to the inner wall of the space station.

QUESTION 02

This question was based on an interrupted pendulum. This context has been tested in the past. It was clear that many students understood that the situation could be treated as two pendulums of different length.

Question 02.1 was expected to be relatively straightforward. Many students realised that the constant maximum value of y indicated that the energy was constant but failed to explain their answer. Students who referred to this as the '*amplitude*' of the oscillation were not rewarded as the amplitudes of the two pendulums are different. The best answers made a clear link between Figure 6 and the variation of kinetic energy and gravitational potential energy (GPE) with time, making it clear that at peaks all of the energy of the system is GPE.

The calculation in question 02.2 discriminated very well. Just over half of the students obtained full marks. The mark scheme was designed to reward partial credit so that over 75% of students obtained at least one mark.

The calculation in question 02.3 also discriminated well. The mark scheme had four clear marks so that it was relatively easy to award partial credit to those students who set out their answer clearly. Students should look at the marks available for a question as it gives an idea of how many steps the examiners are expecting to see.

QUESTION 03

This question assessed the understanding of gravitational fields in the context of an object leaving the surface of the moon.

Question 03.1 has been asked many times before in different forms. Surprisingly only 34% of students obtained both marks. The best answers made it clear that the zero of gravitational potential is at infinity and that objects lose potential energy as they get closer to the moon. Answers that failed to get credit showed a lack of clarity about whether the field was doing work or not.

Question 03.2 had a relatively straightforward first mark for knowing that at the maximum point the two fields are equal and opposite. Far fewer students gave the extra detail for the second mark, explaining the maximum in terms of the direction of the net force, for example. A common error was the idea that the rock passed from the gravitational field of the Moon to the field of the Earth. Better answers were produced by students who realised that the two fields combine.

Question 03.3 tested the relationship between field strength and potential. The mark scheme ensured that students were rewarded according to their level of understanding. This meant that the question discriminated well. In the best answers students drew an accurate tangent to the curve on Figure 7, calculated an accurate gradient and used it to determine the field strength. Students who simply took readings at one point rarely scored more than one mark.

The calculation in question 03.4 was more straightforward, with nearly 50% of students gaining all three marks. The mark scheme ensured that this question discriminated very well as partial credit was available for incorrect answers. Students should be reminded that this credit can only be given when answers are set out clearly.

QUESTION 04

This question assessed electric fields in the context of the oil-drop experiment. All of the information required by a person unfamiliar with this context was provided so that they could answer the question.

Question 04.1 was a '*show that*' question. In order to gain full credit, students were required to make their method clear. The difficulty most students had was with the minus sign. It was insufficient to state that the charge is negative. The best answers added together the weight and electric field force and equated it to zero. An alternative that was given credit was to draw the forces clearly, showing that they were in opposite directions.

Question 04.2 was the most discriminating question on the paper. Each step in the calculation had an independent mark, so that students were rewarded for what they knew or understood. Many students had problems with the units of distance or separating out the field strength from the plates and the drop. Many students tried to use the equation from 04.1, but this rarely led to a satisfactory answer.

There were many correct answers to question 04.3 and yet only about 50% of students obtained both marks.

QUESTION 05

This question assessed capacitance in the context of a discharge circuit and graph.

In question 05.1, most students understood that the area under the graph represents charge but few went on to explain how the charge *remaining* was related to this area. Students should read the question carefully to avoid slips of this kind.

The calculations in question 05.2 and 05.3 were both answered well, with 80% and 60% of students getting full marks, respectively. A common error in 05.3 was to use the area of the graph to obtain a charge. This was given some credit but full marks were not awarded as it is clear that the capacitor does not fully discharge in the time given.

Question 05.4 required students to deduce the operation of the switch in Figure 10. The students also had to realise that they could only use the components in that diagram. Most students realised that either the ammeter or resistor had to be placed next to the capacitor. Many fewer students realised that both components had to be in that position.

In question 05.5 examiners were expecting to see a line that followed precisely the dotted line in the graph. Many students realised that the graph would be a similar shape but only obtained one mark as their line was shifted in some way.

QUESTION 06

This question assessed magnetic fields in the context of a generator.

The calculation in 06.1 was straightforward. Most students obtained a correct value for the number of turns, and the majority of these realised their answer had to be a whole number and were therefore given the mark.

Question 06.2 was much more demanding. The majority of students were able to quote Faraday's law but far fewer were able to link it to the diagram. Examiners needed to see some idea of what caused the change in flux linkage for both marks to be given.

Question 06.3 was also relatively demanding. There were a variety of approaches that gained full credit, but only about 20% of students obtained both marks.

Question 06.4 discriminated very well. Most students were able to obtain a value for the period and gain one mark. Some of these went on to suggest a time base. The y-gain determination required an extra step and proved to be more demanding.

Question 06.5 also discriminated well, with two clear marking points. Most students appreciated that the period doubled. Fewer were able to work out the drop in the peak value. Graphs that did not look sinusoidal were not rewarded. Students should practise drawing sine curves as part of their classwork.

QUESTION 07

This question assessed radioactivity in the context of a smoke alarm.

Question 07.1 produced a good spread of marks, with about 30% of students gaining all four. A common error was to use inconsistent units so that the activity was in Bq, but the decay constant was in year^{-1}. Partial credit was awarded for students who did this. A common discriminator in questions of this kind is to use different units and therefore students should be familiar with converting half-lives and decay constants into SI units.

Question 07.2 was very challenging. In many answers it was unclear whether the combined activity was too low due to Np having a long or short half-life. Either route was given credit, but the explanations had to be clear.

SECTION B

The multiple-choice questions covered parts of the specification not covered in Section A.

There were four questions that were very accessible, with over 80% of the students giving the correct answer. These were B21, B14, B11 and B8. Despite being so accessible, B21 was the most discriminating question in Section B.

Several of the questions were relatively demanding, where less than half of the students gave the correct answer. These were B20, B16 and B12.

B20 was the only question which had an incorrect answer that was more popular than the correct one. The question is about eddy currents in the transformer. Most students chose the idea that eddy currents are in phase with the magnetic field, forgetting that induced emfs are related to the rate of change of flux linkage.