Examiners' Report
Principal Examiner Feedback

October 2024

Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH14) Paper 01
Further Mechanics, Fields and Particles

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October 2024
Publications Code WPH14_01_2410_ER

Introduction

The assessment structure of Unit 4: Further Mechanics, Fields and Particles is the same as that of Units 1, 2 and 5, consisting of Section A with ten multiple choice questions, and Section B with a number of short answer questions followed by some longer, structured questions based on contexts of varying familiarity.

This paper allowed candidates of all abilities to demonstrate their knowledge and understanding of Physics by applying them to a range of contexts with differing levels of familiarity.

Candidates at the lower end of the range could complete calculations involving simple substitution and limited rearrangement, including short structured series of calculations, but could not always tackle calculations involving several steps or other complications, such as accounting for a number of turns on a coil, considering the directions of electric fields when combining them or considering the forces on both sides of a coil when calculating the resultant moment. They also knew some significant points in explanations linked to standard situations, such as electromagnetic induction, the use of drift tubes and charging a capacitor, and could generally set out their ideas in a logical sequence, but could not always identify which points were most relevant for a particular context, even when it was a familiar one.

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, with most points included in ordered explanations of the situations in the questions.

Section A

The multiple choice questions discriminated well, with performance improving with across the ability range for all items.

The percentages with correct responses for the whole cohort are shown in the table.

Question	Percentage of correct responses
1	85
2	73
3	76
4	59
5	28
6	90

7	86
8	81
9	77
10	39

More details on the rationale behind the incorrect answers for each multiple-choice question can be found in the published mark scheme.

Q11

A large majority of students scored all three marks for this question, with most of the rest completing the calculations correctly but not making a comparison and/or a conclusion as required in a 'deduce whether' question such as this. The most common route was to calculate both values in joule.

Q12a

About half of the entry were awarded full marks for this diagram. Those drawing 4 lines were more likely to achieve the requirement for equally spaced lines than those who drew 8, although 8 lines was the most frequent response. It was almost impossible for a student drawing an odd number of lines to achieve this, as it was for those who did not use a ruler. Arrows were very rarely in the wrong direction.

A sizeable number drew equipotential lines as well as electric field lines, but only rarely labelled the lines to show which was which. The examiner cannot choose between alternative answers provided by students, so these responses were not credited.

Q12b

The great majority used the equation for the electric field at a point due to a charge for both charges correctly, although some calculated the force instead by including the product of two charges. Nearly half of them, however, did not correctly apply the direction of each field calculating the resultant, subtracting one value from the other instead of adding the magnitudes. Some students wrote r^2 as the denominator, but didn't actually square the distance in their calculation.

Q13a

Students only rarely did not complete this successfully. Some students incorrectly applied powers of ten, not appearing to be certain of the use of SI prefixes, and some did not include 98% in their calculation. As this was a 'show that' question, students were expected to show their full working, but some skipped steps.

Q13b

Most students gained some credit, generally for mentioning relativistic effects, but full marks were not commonly awarded. Some mentioned time dilation, but did not clearly state the effect on particle lifetime. When students included the first two points, they often just finished by stating something like 'so the particles are able to reach the ground', effectively repeating the question, without commenting on the particles travelling a greater distance.

Q14

The marks most commonly awarded were 1, 2 or 3, with 4 or more being rare. Answers were generally presented in a logical sequence, but did not include the detail of all of the indicative content points. Students often didn't state plainly that there was a current when the switch was closed, even though they were guided specifically to discuss the current. One of the most common points made was that the charge on the capacitor increased, although some just said that it charged, which gives insufficient detail and, again, does not address the point highlighted in the question. Others referred to the charge increasing exponentially, which is not the case. Quite a few attempted to answer in terms of movement of electrons, but often addressed the situation on one plate only if they did this. Another common point was that the current decreased, but rarely with reference to the change in p.d. across the resistor and capacitor. Students referred to the rate of charging decreasing more often that the rate of increase in p.d. The full detail for the final point was rarely included.

Q15ai

A majority of students were credited for a reference to Fleming's left hand rule or the perpendicular force on a current-carrying wire in a field, but only about half of these went on to correctly state the direction of the force on both sides of the coil, as required. Some tried to explain in terms of Lenz's law and electromagnetic induction.

Q15aii

Most students applied $F = BIl$ and moments, but quite a few mixed up the length and width of the coil and some attempted to use the area of the coil when calculating the force. In the moment calculation, some students only included the force on one side of the coil and some didn't take into account the number of turns on the coil.

Q15bi

The majority of students gained at least one mark for stating that emf was induced, correctly using both terms, and about half of the entry were fully successful. Reference to flux linkage was more common than to lines of magnetic flux, although some just referred to changing magnetic flux, which wasn't sufficient for either.

Q15bii

Nearly a third of the entry gained full marks for this multi-step calculation, with the majority gaining at least 4. The most common reasons for not getting the final mark were omitting the 32 turns, confusion over applying the quarter turn by applying an extra factor of 4, and not making a clear comparison and conclusion at the end.

Q16ai

This was completed straightforwardly by the great majority, although a few students went astray by using $v = u + at$ and some failed to square t. Answers were all given to the extra significant figure required for a 'show that' question.

Q16aii

Students generally completed this calculation correctly, although some thought they needed to square r and a few used the Boltzmann constant as k.

Q16aiii

As is common in 'deduce whether' questions, the calculations can be done in different orders to compare different pairs of quantities. In this case, there were roughly equal numbers of students comparing forces and accelerations. Some students attempted to use the Coulomb equation for force, either squaring their calculated charge or using the product of this charge and the charge of an electron. Some students completed the calculations correctly and didn't make the required comparison and conclusion and some made the comparison but concluded incorrectly that this must be the only force.

Q16bi

This question required specific comparison of section XY of the model with drift tubes in a LINAC, but most students made wider comparisons of the whole model with complete LINACs so relatively few gained significant credit for their responses.

Of the relevant responses, the most common similarity was to note that there is no acceleration in the corresponding section for both and the most common differences were the absence of charge for the model compared to the charged particle in the LINAC and that the sections have constant length in the model as opposed to the changing length in the LINAC.

Where students had the right idea, they often only described the situation for one of them, for example stating that the sections have constant length in the model but not mentioning the increasing length of drift tubes in the LINAC. Another example is stating that the ball doesn't spend the same time in each successive XY section without statin that the time spent in rift tubes is constant.

Comparisons not related to the relevant parts were often about the use of the electric field in the model or LINAC to accelerate charges – which is the thing that specifically doesn't happen in the parts they were required to discuss. A difference sometimes noted was the use of DC in the model and AC in the LINAC, but p.d. was not relevant to the sections under discussion.

Q16bii

A majority of students got two marks for stating that the particles spend the same time in each drift tube and that the length of the drift tubes increases, but only about a tenth of them used the increasing speed to make the link between these two observations in sufficient detail by mentioning the greater distance travelled.

Q17ai

Well over a third of the entry gained the full 9 marks for completing the three sections of 17a correctly and straightforwardly, with over a half getting 7 out of 9. Part ai was high scoring overall, with some students trying to use the volume of a sphere and a fair few trying to use equations for circular motion.

Q17aii

Students who had difficulty in part ai were still able to use the 'show that' value given to complete this part, which a majority did. Not all students included a correct unit and so could not be awarded both marks because the magnitude and unit are both required to correctly describe a physical quantity.

Q17aiii

The majority of students were able to apply change in momentum divided by time to correctly calculate the force. A significant majority, however, gathered values from the question and their prior working with circular motion equations to attempt to calculate centripetal force.

Q17bi

Given that this was a relatively familiar and straightforward application of forces to circular motion, it was surprising that the slightly under half of the students were able to complete the diagram correctly. About two thirds of them gained at least one mark, most commonly for weight or *W* or *mg* – although some did not get this because they labelled the downward force as G or gravity.

A large proportion ignored tension, many adding a 'centripetal force' instead, which is incorrect because, when there is circular motion, the 'centripetal force' is the resultant of all the forces rather than a specific force itself. Some students confused the situation by adding both tension and horizontal and vertical components of tension.

Q17bii

A large majority got all three marks, seeming to be quite familiar with this proof. The most common successful approach was starting with the vertical and horizontal components of tension and equating them to weight and the resultant force respectively and going on to show sufficient steps to arrive at the final answer – although sone skipped too many steps and did not get full credit.

Some students appeared less familiar with this and appeared to reason backward from the final answer to choose a suitable starting point. This often seemed to involve what they thought was a component of some sort, but using tan. This approach was not successful.

Q17biii

A large majority completed this successfully for 3 marks and very few were unable to score at least one for using the equation in part bii. Among those who calculated v correctly but could not complete the whole question, a common error was to say $\omega = vr$ rather than $v = \omega r$.

Q18a

About two thirds got full marks here. Some completed the calculation correctly but did not include the unit for magnetic flux density and some used a value of 1 for the charge.

Q18bi

Over two thirds got this correct. Incorrect answers included meson, hadron, a quark combination, fundamental particle, anti-particle, lepton, proton, electron, positron.

Q18bii

Most students were able to identify the charge and lepton number of the three particles for 2 marks, but fewer than half of those who did went on get the next 2 marks because they did not show explicitly that the values before and after the even were the same. Some just gave the quantum numbers and then stated that they were conserved without the required detail to support this conclusion. Some wrote things like +1 → +1 + 0, where they needed to go on to show that the total before was +1, the total after was +1 and that these were equal before making their conclusion.

Some students applied charge values as lepton number values as well.

Q18biii

The overall performance on this fairly complex question was very good, with nearly half scoring all 6 marks.

Some students calculated the final magnitude but not the angle and vice versa for others. The unit for momentum was not always given, although the degree sign was not omitted from the answer for the angle.

Those who weren't able to complete this question sometimes got their components the wrong way round and others ignored the angles altogether and treated it as if the momentum was all in the same direction.

Q18biv

The majority scored at least 2 marks here in a variety of permutations, most frequently for showing a path with clockwise curvature and a smaller radius than for the sigma particle. A large number realised that the neutron would have no track and were careful to draw a track for the pion only. The most commonly missed mark was for the correct initial angle, with the line often starting pointing too far up the page.

Paper Summary

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

Learn standard descriptions of physical processes, and required procedures, such as electromagnetic induction and the use of drift tubes in LINACa, and be able apply them with sufficient detail to specific situations, identifying the parts of the general explanation required to answer the particular question.

When substituting in an equation with a power term, e.g. square, don’t forget it in the calculation.

Be sure to know the standard SI prefixes and be able to apply the correct power of ten.

Where you are asked to make a judgement or come to a conclusion by command words such as ‘deduce whether’, you must be sure to make a comparison between the relevant calculated quantities and those given in the question and make a clear concluding statement.

Physical quantities have a magnitude and a unit and both must be given in answers to numerical questions.

When deriving an equation, be sure to show each of the equations being used separately before substituting it.

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