Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Level
In Physics (WPH14)
Paper 01
Unit 4: Further Mechanics, Fields and Particles

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General Information

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 structured series of calculations, but could not always tackle calculations involving several steps or other complications, such as identifying the correct trigonometrical function to apply with a given angle. They also knew some significant points in explanations linked to standard situations, such as alpha scattering, electromagnetic induction and LINACs, but missed important details and did not always set out their ideas in a logical sequence, sometimes just quoting as many key points as they could remember from the mark schemes for previous papers without particular reference to the specific context.

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	67
2	84
3	60
4	44
5	19
6	34
7	66
8	59
9	73
10	54

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

Section B

Question 11

(a) Only about half of the entry correctly applied the formula for electric potential, with many others calculating the Coulomb force, the electric field strength or the electric field strength multiplied by a distance in an attempt to apply V = Ed. Not all students realised that the charge for a helium nucleus is 2e.

(b) Relatively few students stated a sensible assumption, the most frequent being that it is a point charge. Common incorrect answers included a uniform field and that the atom was in a vacuum, failing to appreciate theat the distance was less than the atomic radius.

Question 12

(a) The majority correctly identified the two forces, although some drew the tension arrow beside the string or the weight arrow near the bob instead of passing through it. A number of students failed to score by adding the components of tension, to an otherwise correct diagram. Another incorrect force seen was centripetal force. A few only said gravity instead of weight or gravitational force.

(b) (i) Only about half of the entry made any headway with this part, few of them completing it successfully. Having seen *l* cos*q* in the required formula, many students said that this was equal to the radius. Many students got sine and cosine the wrong way round when resolving as well. The question required the derivation of the formula, which means from formulae they are expected to use according to the specification, but many started from derived formulae such as $F = mg \tan\theta$, and could not, therefore, be awarded full marks.

(b) (ii) There was a range of approaches, with students able to answer the question by calculating period, length, angle, angular velocity or even *g* and then compare their answer with the value in the question. Students were generally successful, although some failed to make a final confirmatory conclusion as required. A few students did not take the final square root when calculating angular velocity even though it was shown in their working.

Question 13

(a) This question required students to demonstrate their ability to structure an answer logically, showing the links between related points, with up to two of the six marks being awarded for this. The mark scheme shows the process of awarding marks for structure.

As in previous questions about alpha scattering, students are able to demonstrate knowledge and understanding but rarely apply it to the particular question, usually simply stating the observations and linked conclusions as initially taught in class and not addressing the particular question. The most common mark awarded was 4, usually for the last four indicative content points with suitable structure and linkage, but not addressing the tissue paper statement by stating the expectations based on the exisiting model and how the observations changed the model. Those scoring fewer than 4 marks were generally not specific enough, e.g. ‘there’s an empty space in the atom’, and ‘there’s a dense place in the atom’.
A few students appeared to think the questions was about actual military shells and/or real tissue paper.

(c) About half of the entry scored here, usually for soemthing rlated to alpha particles being strongly ionising or a suggestion related to the number of atoms encountered.

Question 14

(a) Most students stated that the capacitor stored charge or energy, but they often failed to gain further marks because they just said that the capacitor would discharge and did not link it to the controller circuit, often saying instead that it would disharge across the resistor. Students rarely addressed the ‘for a short time’ part beyond just repeating it.

(b) Most students were able to complete this. The most common error was using ln4/ln12. Some students were only able to calculate the time constant and a few attempted to use Q = CV and t = Q / I.

(c) Few students scored well here. Most were able to show exponential decrease somewhere on their diagram, although some reached the time axis, but little beyond that. A common response was two spikes, each followed by exponential decay. Quite a few students calculated the initial current, but few showed it as the value for the first 20 seconds.

Question 15

(a) Nearly half of the entry completed this part correctly for the full 5 marks. Of those who did not, a common error was to do effectively do the parts in reverse, incorrecty applying energy transfer for part (i) and momentum for part (ii). As is common with ‘deduce’ questions, the final part allowed students to calculate from a range of variables, including energy, possble height, required speed and speed at the top of the ride, although some failed to gain full credit by not including an explicit comparison in conclusion.

(b) Most students were able to score at least one mark for a relevant statement about indiced emf or the magnetic field, often by quoting a standard electromagnetic induction response without much application to the context, although they lacked precision in their descriptions of the change in magnetic flux linkage and sometimes referred to a coil, which does not appear in the question.

A substantial minority were able to describe how this led to a current, but few explained the interaction of magnetic fields successfully. Lenz’s law was often invoked vaguely, saying that the emf would oppose the change creating it, but not linking this to the field and forces produced.

Question 16

(a) Most students were familiar with the required fiels but many did not gain full credit through insufficient care with their diagrams, leaving gaps, not using a ruler or irregularly spacing the lines.

(b) Students were generally able to calculate the correct force in part (i), although some attempted to use $E = kQ/r$ or $F = kQ/r^2$. Some did not include the extra significant figure for a 'show that' question.
While a good proportion went on to complete part (ii), some were unsure of what was required. A fair number completed the correct energy calculation but drew he opposite conclusion. When applying force times distance it was not altogether unusual to see students using the distance between the plates.

(c) Only about a third of the students gained credit for their responses, usually for stating that the muons were travelling at speeds close to the speed of light. Some went on to refer in one way or another to time dilation, although not always linked to particle lifetime. Statements explicitly linking this to distance travelled were rare, often just repeating the question.

Question 17

(a) As with question 13, many students did not address the particular question but just wrote everything they knew about the general context, here apparently answering a question 'Describe how a LINAC works' rather than the question on the page. Even so, this enabled most of them to gain 2 or 3 marks from the first three marking points. Students often indicated an awareness that the time in the tubes was linked to the a.c. frequency, but could not make this link specific.

(b) Most students were able to calculate the mass of the omega in kg in part (i) and these students quite often went on to apply $E = mc^2$ for the energy in J, and many then completed this for the required answer, although some were unsure of the powers of ten linked to SI prefixes throughout part (b). Students occasionally used nucleon mass rather than electron mass.

Part (ii) was more challenging, with the great majority of students not appreciaiting the need to subtract 1.7 GeV. A few got confused with factors of 2. Seeing 'kinetic energy', some students used $\frac{1}{2} mv^2$ with the speed of light, whereas they should know that particles with mass cannot travel at the speed of light.

(c) It appeared that many were only aware of energy, momentum and charge conservation as the majority attempted to say that one or more of these were not conserved. Others referred to lepton number conservation. Students selecting baryon number generally said sufficient to gain credit for marking point 1 and/or 3, but sometimes missed this through insufficient detail, e.g. not referring to the actual baryon number before and after the event or not stating explicitly that baryon number conservation would be broken. Very rarely was the idea of a baryon-antibaryon pair suggested.

Question 18

(a) Most attempts related to the direction of the track only, but they often only said the same direction, which is not true because a curved path is always changing direction, or they said it followed the same path. Students did not often refer to the curvature, which was what was required. The absence of other charged particles answer was notable for its almost total absence in student responses. Many of them seemed to think they were explaining why they could see a track, which involved the same ideas but applied incorrectly.

(b) Students often mentioned one or two of the mark points and gained credit, but they were not often sequenced and linked to form an explanation.

Some said that the anti-muon has the opposite charge to a muon and so spirals in the opposite direction. Others got the radius and curvature confused, saying that the curvature decreases rather than the radius.

(c) Two thirds got this correct, but incorrect answers were not just ‘into the page’, as might be expected, but included up, down, right and left.

(d) A straightforward 3 marks for the majority. Some failed to be awarded the final mark because they omitted the unit. Some used a charge of 1, recognising that the chrage was the same as that of a proton, but not giving it in C.

(e) (i) Only about a third got this fully correct. A lot of candidates were unaware of the correct symbols. Extra particles were often included. Some didn't show that an anti-muon was produced rather than a muon.

(ii) While it is understandable that many students may prefer to solve such problems by calculation when there is a choice, drawing accurate scaled vector diagrams is a required skill for the examination. Quite a few students made the deduction straightforwardly after successful calculation using the cosine rule but could only be awarded the final mark without a diagram. Half of the students got no marks, even though 1 mark could be awarded for a single labelled vector. Of those attempting a vector diagram, many used no labels and some had labels but no arrows. Students did not always showtheevidence of a scale being applied. The vector diagrams were often completed incorrectly, with momentum for a particle other than the pion as the longest side. Some just attempted to compare total momentum before with total momentum after by adding the momentum values without any reference to angles. The angle of 18 degrees was frequently assumed for the both acute angles in the triangle. Finally, even when perfect scale diagrams had been produced, students rarely made a statement linking this to a correct conclusion.

Paper Summary

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

- Where you are asked to come to a conclusion by command words such as 'determine whether' or 'deduce whether' using numerical data, you must complete your calculations, then explicitly compare the relevant values and then make a clear statement in conclusion – 'Calculate, Compare, Conclude'.
- Show all steps and substitutions clearly in derivations and start from standard basic formulae.
- While vector questions may be solved by calculation or scale drawing, you must be able to adopt either approach when directed to do so in a particular question.
- Address all points specifically mentioned in questions, such as the inclusion of diagrams.
- Learn standard descriptions of physical processes, and required procedures, such as electromagnetic induction and linear accelerators,

and be able apply them with sufficient detail to specific situations, identifying the parts of the general explanation required to answer the particular question.

- While past paper mark schemes can be useful revision aids, questions will not be identical so quoting them directly is unlikely to answer a particular question. Be sure to answer the question on the paper and not a question from a previous paper with a similar situation.
- When substituting in an equation with a power term, e.g. square root, don’t forget it in the calculation.

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