Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2023

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

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 identifying the charge of a particular nucleus. They also knew some significant points in explanations linked to standard situations, such as electromagnetic induction, 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	89
2	88
3	86
4	53
5	80
6	86
7	65
8	88
9	58
10	38

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

11 The great majority of students achieved full marks for this question, but there were a number of common errors among the minority who did not. Some left there answer in terms of pi and some omitted to give the final unit. Some applied the factor of 2 incorrectly, doubling the final speed, and some failed to apply it all. A number calculated 6 rotations per second rather than 6 seconds for one rotation.

12 The majority were awarded the full 3 marks. Errors seen included omitting the factor of 2 when applying $E_K = p^2/2m$, not completing the square root, treating the electron as a photon by applying $f = E / h$ and then wavelength = c/f and calculating v but not multiplying by mass for momentum.

13 Again, the majority of students achieved the full 3 marks. A number of students used the mass as force, without multiplying by g, and a fair few made power of ten errors with the units g and mT.

14 A majority gained at least one mark, generally for stating that a centripetal force was exerted on the passenger. Some students did not get this mark because they only said that the force was at right angles to the motion without indicating that it was towards the centre of the circular path. Quite a few who did state the direction of the centripetal force as towards the centre went on to apply Newton's 3^{rd} law and say that there was an equal and opposite outward force, which was the centrifugal force. They did not always realise that the 'centripetal force' is the resultant force acting on an object following a circular path rather than a separate, specific force.
Many students just stated that there is no centrifugal force, without addressing the 'outward force' part of the claim.
In general discussions of circular motion, it might be helpful for students to think of the perception of an outward force as a centrifugal *effect* rather than attempting to eliminate use of the term 'centrifugal' and just saying that there is no such thing as a centrifugal force.

15a About a third of students gained full marks, while most of the rest calculated the energy in joule but didn't get much further. Most of these did not realise that they needed to consider electric potential and attempted to use the Coulomb force or electric field strength in some way. Occasionally when the correct formula was used, the Boltzmann constant was used for k. Quite a few students had difficulty with applying the correct charges, omitting 2 and 79 or using 4 and 179, for example, and some used proton mass instead of electron charge. The M in MeV was sometimes ignored.

15b About half got both marks here and the other half got zero, often because they omitted the square when substituting values so they could not be awarded the 'use of' mark. A small number got 1 mark because they didn't square when calculating or they omitted the unit. Errors in part (a) were seen here as well, such as not using the correct charges, using mass instead of charge and using the wrong value of k.

16 The great majority were awarded at least one mark and about half gained 2 marks. Even if they didn't get all of the indicative context, answers were generally well structured, although it was not always clear which part of the graph they were referring to for the different parts of their answer.
The most common indicative content point made was referring to the change in flux linkage, although many were not credited because they only said change of flux. Students often stated that the size of the induced emf was proportional to the rate of change of flux linkage, but

could not apply this to the situation in the question. They generally attributed the change in direction of the emf to a change in polarity rather than to the flux linkage now decreasing rather than increasing, as it had been when the emf was positive.
Some students could have been attempting to repeat an answer to a different question they had revised where the magnet is dropped through a long coil because answers often referred to the magnet being in the centre of the coil rather than when the centre of the magnet was in the coil.

17a Students were split fairly evenly between those who scored full marks and those who scored none.
Most of those completing this question successfully either knew E = Blv or were able to apply Faraday's law. A fair number equated Bqv to qV/d, although it was not clear that they knew how this was justified in terms of balancing the magnetic and electric forces on a single free electron in the wire. Whichever method was attempted, some students got *v* (velocity) and *V* (potential difference) mixed up.

17b Fewer than a third of students gained credit for this question. Many knew that Lenz's law was required, but could not quote it correctly or describe its application to this situation. They tended to just say that the induced emf was opposite to the motion, which cannot be true when they are perpendicular, rather than that the emf would be in a direction such as to cause a force in the opposite direction to the motion of the rod. Many just chose a direction and said it was by Fleming's left (or right) hand rule.
Some said that the direction of a current , without necessarily realising that there is no current in this situation, would be from P to Q so the emf would be from Q to P.
Quite a few used vaguer terms to define the direction, such as down, rather than using P and Q for reference.

18a The majority were able to calculate the capacitance correctly, more often by substituting values from the graph into the capacitor discharge equation than by using the time constant. About a third of those did not go on to explain whether this was within the stated tolerance. A number of students misread the initial voltmeter reading as 14 V by counting the squares up from 10 and not checking the next scale value.

18b About half of the entry were applied both formulae correctly to calculate energy stored, although quite a few did not complete the comparison and conclusion fully. A substantial number did not identify the relevant data correctly and applied a p.d. of 12 V to the ultracapacitor as well, using $W = ½ CV^2$ for both to obtain a ratio of about 10 000.
Some students had a problem with C as the unit of charge and *C* as the symbol for capacitance.
Although the formulae are given, W = ½ CV, $W = Q^2/C$ and W = ½ QV were all seen and a number omitted the square when substituting or in the calculation.

19 a The majority were able to calculate the speed correctly, but they did not all gain full credit because they did not include any reference to the mass. This allowed the correct answer to be obtained since mass was a common factor for each value of momentum, but its omission needed explanation in a 'show that' question. Some students gave their answer as 1.3, forgetting that 'show that' questions require one significant figure more than the quoted answer.

19b Most candidates calculated kinetic energies, but some attempted to do so using components of velocity from their earlier calculations even though all of the velocities were known from part (a). A significant proportion were not awarded the final mark because they just stated their conclusion about elasticity without making a clear statement comparing values before and after the collision.

20a Nearly half of the entry completed this successfully, generally following the format of the mark scheme. Most other students at least applied the capacitance formula given and many of those went on to calculate charge, but they did not know how to proceed further, some attempting to apply a radial field, using either the plate separation or sphere radius as r. Students had already shown a preference for using k rather than e_0 earlier in the paper, but many went wrong using it here, applying it as $C = kr$ rather than $C = r/k$.

20b Students often gave answers indication a general understanding of the situation, but without specific details. An example would be 'the sphere touches the plate, then gets charged, so it gets repelled and touches other plate so the same thing happens again' without discussion of the polarity of the charge of the plates or of the sphere at different stages. Candidates who stated that the sphere was positive or negative at the start wrote a more coherent response. Typical errors include 'The p.d. between the plates switches', 'Once the sphere touches a plate it discharges and becomes neutral', and 'Positive ions flow off the sphere / plate'.

20c Students seemed to overlook the key words 'starts to move' and most answers were some sort of repetition of part (b), where the sphere was charged at the start. Very few suggested movement of electrons in the conducting material.

21a The majority made suitable suggestions. Many of those who did not simply stated quark-antiquark without naming any quark flavours and some gave quark-quark examples. A few gave 3 quark suggestions.

21b Nearly half gained full marks, usually for conservation of charge and lepton number. Some gave insufficient detail, for example stating that the charge was −1 before and after without stating the charge for each particle.

21c Nearly all of the students calculated energy in joule correctly, with two thirds of the entry gaining full marks. A common error was to neglect the M in MeV. Some students rearranged the mass-energy formula incorrectly.

21d Half of the entry were awarded both marks for a fully correct answer. A significant number stated that there would be an increased lifetime, but did not refer to relativistic effects so they did not get that mark.

22a Students did not perform well on this question through lack of specific detail. For example, some just stated that the electrons were attracted to the positive plate. Others referred to a force on electrons in the electric field but did not state that this was in a vertical direction. Others stated that the force was at right angles to the motion without realising that this was only the case as the electrons entered the field. Some went on to describe a circular path, even though the question told them it was parabolic. Students only occasionally referred to horizontal motion, and even less often to this being at a constant speed.

Some students appeared to focus on the diagram rather than the specific question on the paper. They had been told that there was a beam and asked to explain its path, but they gave a prepared answer on the production of the beam by the electron gun.
22bi This was generally well answered, although quite a few used $W = ½ QV$, indicating a dependence on the formula sheet without a full understanding of its contents.

22bii While most students calculated the force on the electrons and could use it to calculate acceleration, many did not know how to proceed further. Some used the centripetal force formula with the force they had calculated to obtain a distance value.
Quite a few students didn't notice that they had been told the electric field strength and attempted to calculate it using 850 V and 7.5 cm and others used the value of E given and the value 850 V to calculate a distance they did not need.
Some students calculated a deflection angle.

22biii students were told to compare values of e/m obtained in to different ways, but many made it more complicated by attempting to use values in the question and a standard value of e or m for an electron to calculate the other of e or m for comparison. Others had difficulty in relating q in $p = rBq$ to e and they often completed calculations they did not need rather than determining that $e/m = v/Br$ algebraically first.
Of those who calculated both values, not all made a suitable comparison and conclusion.

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 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

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 using graphs, read the scale values on either side of the point of interest to ensure you are using the scale correctly.

Familiarise yourself thoroughly with the formula sheet provided and be sure you know what each symbols stands for, not confusing similar symbols such as v for speed with V for potential difference.