Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

January 2022

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

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

January 2022
Publications Code WPH14_01_2201_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 several 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 distance, and therefore angle, to use with a trigonometrical function. They also knew some significant points in explanations linked to standard situations, such as electromagnetic induction and objects following circular motion, 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 reference to the specific context.

Steady improvement was demonstrated in all 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	81
3	89
4	78
5	93
6	73
7	68
8	64
9	62
10	71

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

Question 11

Nearly all students drew a radial field pattern, usually with arrows in the correct direction. Not all of them went on to score the full three marks because their field lines were not distributed evenly. This was particularly so for those who did not use the ruler they were instructed to have by the note on the front of the exam paper.
Several students attempted to add circular equipotential lines to a correct radial pattern, and they rarely labelled which set of lines were the field lines and which were the equipotentials.

Question 12

While most students gained some credit for this question, only a minority were awarded more than two marks. This was often the case for students who appeared to understand the situation but did not express it clearly.

While most realised that there was a downward force on the air, many just referred to this as a push rather than a downward force. The upward force on the helicopter was usually mentioned, but not always the fact that it was exerted by the air and that it was equal to the downward force on the air. The upward force was sometimes referred to as upthrust. Students did not all state that the upward force on the helicopter was equal to the weight, many just saying that these forces were balanced or cancelled out. When students mentioned that the resultant force was zero, they did not often link this to zero acceleration or a wider statement of Newton’s first law.

Question 13ai

While a good proportion of the students were able to complete this part successfully, many neglected the distance between the points of suspension when applying trigonometrical relationships to establish the angle of the thread to the vertical, incorrectly using 0.105 m as the base of their right-angled triangle. The weight was usually calculated, and evidence of correct resolving seen, although rarely diagrammatically.

Although they had no information about charge, a substantial number of students attempted to use Coulomb’s law for this part.

Question 13aii

Students usually used the force from part (i) correctly to calculate the corresponding charge, although quite a few used 2Q instead of Q^2. Although they included Q^2 in their calculation, students occasionally failed to find the square root at the end.

Question 13b

Many students used the charge from part (a)(ii) correctly to calculate the corresponding electric potential, but some used the Coulomb force formula instead, with r^2 rather than r.

Question 14a

Students had little difficulty in calculation the correct initial current, but about half of those who did get the correct value did not make a clear reference to the value on the graph to conclude that the values were consistent. Some students approached the problem using the current from the graph to arrive at a value of resistance or p.d., in which case they usually made a clear reference and comparison to the value on the diagram.

Question 14b

Only about a third of the students were able to state that the current would be the same for both ammeters and only half of these explained that this was because they were in a series circuit. Quite a few thought that one ammeter would show an increasing current while the other was decreasing.

Question 14c

This was generally well answered, most frequently using two values of current from the graph with the next most common approach determining the time constant from the initial current multiplies by 1/e. Some students used the area under the graph to determine the charge and then used C = Q/V, usually with sufficient accuracy.
The correct unit was not always stated.

Question 14d

Quite a few students misunderstood this and applied exponential decay to calculate the charge as if the capacitor was discharging, generally calculating the correct final charge but using it as the initial charge. The correct unit was not always used, some appearing to confuse the unit with the symbol by using Q. Students rarely used the area under the graph for this part unless they had used it in part c.

Question 14e

Most students who had answers for parts c and d calculated this straightforwardly.

Question 15a

It was not clear whether many students realised that they were expected to be able to derive this equation as a majority gained no credit, quite a few not making a start or just stating $F = mv^2/r$ and dividing by m. Of those who attempted a correct method, about three quarters were able to complete it successfully, although they did not all include the vector diagram required by the question. Some students had a diagram of the correct general form, but mixing r and v rather than using similar triangles.

Question 15b

The majority completed this correctly, although the unit was sometimes omitted. Some students incorrectly applied 1.3 revolutions per second, either using it as the time for one revolution or as 1.3 revolutions per minute. Some did not apply the square in their calculation and quite a few did not give a unit.

Question 15c

Just under half of the entry were awarded marks for this question. Most appeared to have a general understanding but lacked clarity in their responses and did not state assumptions that they may have taken for granted.

The most common missing statement was that the force on the hand was equal to the tension in the string and the next that the centripetal force was constant. Although the answers suggested that many appreciated both, a clear statement was required as part of the required discussion.

The most awarded mark was for appreciating that the resultant force at the top was equal to the weight plus the tension, although this was not always linked to the centripetal force. Those who wrote clear force equations for the situation at the top and the bottom were most likely to be awarded the final two marks, although many did not make a clear conclusion including the force on the hand explicitly.

Question 16a

Just under half mentioned ionisation and about half of those linked it to the formation of tracks. A lot of students answered a different question to the one on the page, perhaps one that they had seen before, about the curvature of the tracks caused by the magnetic field.

Question 16bi

The great majority scored two marks. One of the most common reasons for not being awarded the baryon mark was saying 'three quarks or antiquarks', which is ambiguous as it suggests the possibility of a combination of quark and antiquark. 'Three quarks or three antiquarks' was accepted.

Question 16bii

A majority gave a correct response, although quite a few just said that the field was perpendicular.

Question 16biii

The question asked the students to deduce charge and baryon number. The command word deduce requires evidence of their reasoning, and many students did not give this in sufficient detail. The best answers included an equation for the interaction, with a corresponding line below for the charges and another line for the baryon number.

Quite a few students ignored the charge of the proton and thought the charge was -2. Others assigned a non-zero baryon number to the K meson, even though they had successfully described the difference between baryons and mesons in part bi.
Some students attempted to deduce the charge as negative based on the curvature in the diagram, but the diagram didn't show curvature and certainly wouldn't indicate the magnitude.

Question 16c

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.

About half of the students were awarded no marks for this question through lack of detail. Very few included sufficient indicative content to access two linkage marks.
The most common point included was $E = mc^2$ in some form. Many students just made general statements about conservation of mass and conservation of energy, doing little more than stating that they are conserved despite this being stated in the question. Some students elaborated to the extent of using mass-energy conservation, and some set out an equation linking mass and kinetic energy of each particle, although they sometimes missed one of the terms and were therefor not quite correct. While some students did mention conversion of energy to mass, it wasn't always clear which energy and which mass. The high kinetic energy of the K meson was rarely mentioned.
The vector nature of momentum was not often considered, and the only consideration of the y components was generally that the particles moved in opposite directions without reference to the magnitude of the momentum.

Question 17a

Most students stated lepton and they usually said it is a fundamental particle, sometimes quoting second generation. Some also included extra detail regarding lepton number, baryon number and charge, but this was not always correct.

Question 17b

A majority identified the muon anti-neutrino, but the other particle was often just referred to as a pion and not as negative.

Question 17c

The majority completed this straightforwardly, although some failed to include a written conclusion.

Question 17di

Most students demonstrated an understanding of the unit, but they did not all explain in sufficient detail to gain both marks, for example by not linking momentum to mass x velocity. A lot of students followed a base unit route, usually successfully.

Question 17dii

The majority were able to apply r = p/BQ for a suitable selection of values from the question to draw a valid conclusion, although, again, they did not always make an explicit statement. Some misunderstood the question and just showed that 3.10 GeV/c^2 = 1.65 x 10^{-18} N s. A noticeable minority either used the circumference as the radius or appeared to think that the radius was 44.7 m divided by 2. Perhaps they thought it was the diameter.

Question 17diii

While the majority clearly appreciated the situation, over half scoring for the question, a fair number failed to state that the speed was close to the speed of light precluded the award of the first mark. Others restated the question after mentioning the speed of light without mentioning relativistic effects. Quite a few discussed mass increases as a cause of the increased lifetime and others just said time slowed down without much elaboration.

Question 18a

The majority gained a mark for either flux linkage or Wb, with nearly half getting both, but some just said flux or gave units equivalent to Wb rather than stating Wb.

Question 18b

The most common approach was to calculate the average magnitude of the emf using the peak value divided by a quarter of the period to get 4 marks, although many used half of the period and got three marks. Those who used the gradient to determine the maximum emf generally got the correct final answer.

A few candidates confused number of turns with number of rotations.

Question 18c

Most students showed an understanding of the general situation and the establishment of eddy currents, though not by name, in the disc. The first three comments on the mark scheme were credited for most students, stating change n magnetic flux linkage, induced emf and a current in the disc. Students did not often clearly link a force on the disc to the interaction of the magnetic field and the current in the field. Quite a few students gained credit for appreciating that Lenz's law applies in this situation, although statements of the law were often vague. Many interpreted Lenz's law to mean that the force on the disc was opposite to the motion of the magnet rather than that the force on the magnet was opposite to its motion, so they made the wrong conclusion.

Paper Summary

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

- Where you are asked to conclude 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.
- 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 be able apply them with sufficient detail to specific situations, identifying the parts of the general explanation required to answer the 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.

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom