Examiners' Report
Principal Examiner Feedback

January 2020

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

Grade Boundaries

Grade boundaries for all papers can be found on the website at:
https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

January 2020
Publications Code WPH14_01_pef_20200305

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 was the first sitting of the unit.

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 using diameter rather than radius for a centripetal force calculation. They also knew some significant points in explanations linked to standard situations, such as cyclotrons and electromagnetic induction, 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 across the ability range for all items. Candidates around the E grade boundary typically scored about 7 and A grade candidates usually got 9 or more correct. The percentages with correct responses for the whole cohort are shown in the table.

Question	Percentage of correct responses
1	73
2	75
3	29
4	81
5	78
6	97
7	56
8	52
9	91
10	91

Section B

Question 11

The majority of the entry completed this nuclear equation correctly. A significant minority did not use the correct nucleon number for deuterium, although they were told that it has 1 proton and 1 neutron, but they usualy still identified molybdenum and completed the equation consistently with the hydrogen nucleon number of 1.

Question 12

A large majority of candidates were awarded at least 4 marks out of 6 for this question, with over half the entry scoring 5, showing good knowledge of the particles in the standard model. Candidates did not always correctly identify which were the fundamental particles in the model and, despite the question requiring descriptions for the electron and the muon, few referred to the latter being a second generation particle.

Question 13 (a)

Few candidates failed to complete this calculation correctly, with a small minority omitting the factor of 0.5 in their calculation and some attempting a calculation involving gravitational potential energy. As this was a 'show that' question, candidates were required to state their answer to one significant figure more than the value quoted in the question, 0.1 J, but this presented no problem.

Question 13 (b)

The majority of students were able to apply conservation of energy successfully to calculate the maximum speed of the head and initial speed of the whole toy, as required by the question, and to determie the relevant values of momentum. They did not always make the required concluding statement, however, in answer to the question, 'Determine whether ...'. Some candidates attempted to calculate speeds using '*suvat*' equations, despite being instructed to use conservation of energy, and some added the mass of the head to the mass of the whole toy, even though that included the head.

Question 13 (c)

A significant minority included no reference to calculated values of kinetic energy in their responses to this question. It was another 'Determine whether …' question, requiring a supported conclusion, so a comparison of values and a clear statement were required.

Question 14 (a)

The majority of students completed this correctly by calculating the required force or the maximum speed using the stated data. A minority used the diameter rather than the radius in their calculations.

Question 14 (b) (i)

Most students gained at least 2 marks for this derivation, but many did not achieve full marks because they started from $\tan \theta = v^2 / rg$ without using components of the normal contact force. Very few used a vector diagram, which might have been helpful in redirecting those who attempted to find components of weight parallel and perpendicular to the track.

Question 14 (b) (ii)

This was a straightforward calculation which the great majority completed successfully. Some students used the radius or doubled the diameter, and some used a value of speed calculated in part (a), even though the qustion required them to use the 'stated design criteria'.

Question 14 (c)

Nearly half of the entry gained credit for their responses, with about a quarter of those being awarded both marks. While the question asked for advantages, some students only attempted a single suggestion. The most common accepted response related to using higher speeds, but many interpreted the statement about the lack of frictional force perpendicular to the motion to suggest that there would be less wear on the tyres and require less road maintenance. While some recognised that the bend could be tighter, many who mentioned the track thought it could have a bigger bend. Many of the answers lacked sufficient detail for credit, particularly those related to the decreased likelihood of skidding.

Question 15 (a)

The majority of students were awarded this mark, but many lacked the required detail, sometimes referring to alpha particles striking oher particles ‘in the air’. Others referred to the alpha source striking air molecules.

Question 15 (b)

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

A large majority of students were able to state at least two of the observations from the alpha particle scattering experiments, many being limited to two correct observations because they said some particles were deflected by ‘angles less than 90 degrees’ instead of referring specifically to small angles.

Only about a third gained credi for the structure of their answers, often because their conclusions lacked detail. For the conclusion related to the first two observations students rarely stated that either model was thought able to produce this result, just writing that this showed that the atom is mainly empty space. For the third observation the conclusions often lacked any mention of a specific model. Students frequently just stated that this observation showed that mass and charge are concentrated in the nucleus rather than relating them to the need for these concentrations in order to produce the observed deflections.

Question 16 (a)

Students generally knew the polarity of the charge, but only about a third stated this with a satisfactory reason, as required by the question.

Question 16 (b)

The great majority of the candidates were able to calculate the force on a charged particle in an electric field and to calculate acceleration using force and mass, but only about a third included the gravitational force acting on the spider in their calculations, limiting themselves to 2 marks. Students using a free body force diagram before their calculations did not make this error.

Question 16 (c)

A good majority of students were able to use the appropriate formula to calculate the net electric charge on the Earth, but relatively few completed the question beyond that. Some candidates were satisfied with total charge and some went a bit further and divided by 1 m^2. The examiners saw a range of formulae being used for the surface area of the Earth, including those for the area of a circle and for the volume of a sphere, but not often the correct one. Candidates using a formula with the square of the radius did not always include the square when substituting values and some students' made power of ten errors when converting from km.

Question 17 (a)

While the majority were able to apply the formula for the exponential decrease of potential difference or current, relatively few used it with a correct pair of values for the beginning and end of the process. They did not determine the values for a single component, the most frequently used values being 12 V for the whole circuit decreasing to 1.4 V for the LED. While a significant minority were able to calculate the minimum capacitance correctly, they rarely explained their choice of capacitance from the list in terms of achieving the required time.

Question 17 (b)

A reasonable minority of the entry were able to make a statement linking decrease in p.d. across the LED to increase in resistance, and about half of these stated the effect on the time taken, although they did not often explain it in terms of the time constant.
Although they should be familiar with the current-p.d. characteristic for a diode, most others appeared to interpret the graph as if the x-axis showed time as well as current, so that, moving to the right, the graph was presenting a picture of how the current and p.d. for the LED varied as the capacitor discharged. They then often incorrectly implied that resistance equalled the inverse of the gradient of the curve to conclude that the resistance of the LED decreased as the capacitor discharged. Given that they were mistaken in this part, some were able to make a consistent, but incorrect, conclusion opposite to that expected, but they gained no credit for this.

(c) About a third of the entry made a statement suggesting that the capacitor is an energy store to gain 1 mark, but many described more specific uses of capacitors.

Question 18 (a)

A solid majority identified that an emf was being induced and were able to state that there would be a current in a complete circuit. Many also linked this to change in flux linkage, but those who did so in terms of wires cutting lines of magnetic flux did not always word their answers sufficiently well to gain a mark. Only a minority few could link the flashing to the LED, many attempting to describe the variation in output due to change in the angle of the coil relative to the field in a very similar way to the answer on the most recent paper on the legacy specification.

Question 18 (b) (i)

The great majority were awarded a mark for the doubled period, but fewer than half were awarded the mark for halved amplitude. Sometimes they did not change amplitude at all, but often it was drawn too imprecisely to award a mark.

Question 18 (b) (ii)

A large minority gained credit for an explanation of the change in emf, but relatively few for the change in period. A lot of answers showed a general understanding but did not score because they only included reference to increased or decreasing rather than doubling or halving.

Question 18 (b) (iii)

A good majority were rewarded for use of the two equations, for flux and rate of change of flux linkage, but they frequently used an incorrect time for their change in flux linkage and therefore did not reach the correct final answer. Some students used $\varepsilon = BAN\omega$, but used mean emf rather than peak emf and so did not arrive at the correct answer.

Question 19 (a) (i)

This presented few difficulties, with three quarters of the entry being awarded the full 3 marks. The factor of 2π was sometimes not explained sufficiently well to gain the second mark.

Question 19 (a) (ii)

Only about half of candidates scored marks for this question, despite the cyclotron being a familiar context specifically required by the specification. Many candidates appeared to be answering a different question and described the operation of a cyclotron but not linked to the significance of the equation. The most frequently awarded mark was for stating that the time spent in each dee is constant, even

though, when there was reference to the equation, it was often pointed out that the time depends on mass rather than that the time does not depend on speed or radius.
Many students demonstrated that they had some familiarity with the cyclotron but did not give sufficient detail. The question stated that an alternating potential difference was used, but many students who mentioned a fixed frequency did so in terms of reversing polarity only. As electric and magnetic fields are used in this context, a simple reference to polarity is not sufficient.
Candidates occasional wrote 'between the gap' instead of 'between the dees' or 'in the gap'.

Question 19 (b)

Half of the candidates scored on this question, the majority achieving a single mark, usually for applying the formula from part (a) or use of $W = QV$. A significant minority worked through to the end, or nearly the end if they omitted the factor of 2 for the particle passing between the dees twice per cycle.

Question 19 (c)

Only about a third of the students gained credit for their answers, largely because the others were writing answers to a different question. This question was about investigating the structure of nucleons, but many gave answers suitable for a question about using high energy collisions to create new particles – very much like the answer in the mark scheme for the most recent paper on the legacy specification. Those who were addressing the correct question tended to answer it well, although some did not link high momentum to small wavelength and others talked about the size of gaps between atoms.

Paper Summary

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

- Show all steps and substitutions clearly in derivations.
- Learn standard descriptions of physical processes, 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.
- Be sure you know the command words and understand the level of required response for each of them, e.g. explain would mean a candidate must say why something happens and not just describe what happens. There will always be at least two linked marking points for a question asking you to 'explain'.

- 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 describing the effects of forces, a force diagram can help to understand the situation.
- When substituting in an equation with a power term, e.g. x^2, don’t suddenly miss off the index when substituting or forget it in the calculation.
- When a question requires a conclusion, be sure to make a full statement. Repeating the words of the question in a different order will not be sufficient.