Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel

International Advanced Level

In Physics (WPH04)

Paper 01 Physics on the Move

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The assessment structure of Unit 4, Physics on the Move 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 learners of all abilities to demonstrate their knowledge and understanding of Physics by applying them to a range of contexts with differing levels of familiarity.

Learners 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 calculating angular velocity for the number of rotations in a given time or accounting for two particles given the data for one. They also knew some significant points in explanations linked to standard situations, such as linacs 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 and most points were 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. Learners around the E grade boundary typically scored about 6 or 7 and A grade learners 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	76
2	74
3	77
4	86
5	63
6	67
7	72
8	80
9	57
10	57

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

Section B

Q11(a)

In this question many learners demonstrated their knowledge of baryon structure, but not all were successful in showing the six possible combinations of up, down and strange quarks. The answers given showed that a some learners are not clear about the need for combinations of quarks only or anti-quarks only when they included mixtures of the two in their lists of possible hyperons. Others used ambiguous descriptions such as ‘three quarks or antiquarks’ rather than ‘three quarks or three antiquarks’.

Q11(b)

This question about the symmetry of the standard model predicting the top and bottom quarks was taken directly from the specification, but there was little evidence of learners having been prepared for it as very few gained credit for their answers, rarely even mentioning the word ‘symmetry’. Rather than referring to generations of leptons, learners more commonly suggested quarks occurring in pairs which would not be sufficient to lead from the first four discovered quarks to the fifth and sixth.

Q12(a)

This was a straightforward calculation completed successfully by the great majority. Errors seen included a failure to square the distance between the charges in the calculation, halving the distance, multiplying the charge by 2 and omitting the unit N in the final answer.

Q12(b)

Learners who appreciated the vector nature of electric fields and approached the problem methodically with a vector diagram of the relevant fields were at a great advantage for this question. For others, there were a number of errors seen. Some did not refer to the labelled distances and angles to X on the diagram and used their answers from part (a) to derive the field strength due to each charge, despite the distance being different. Others misapplied trigonometrical functions in arriving at their answer. Some learners used an incorrect unit at the end of their calculations, such as N instead of the required N C^{-1}.

Q13(a)

This question included assessment for the quality of written communication and learners generally expressed their answers in a logical manner. The problem for many was that they answered the wrong question. This was an example of learners preparing from past questions but placing too much emphasis on remembering mark schemes. Many learners gave model answers for the increase in length of the drift tubes at the start of the linac and left it at that, gaining no credit. Quite a few learners started with this answer first even thought they were going on to an explanation of the correct situation.

For those addressing the question asked, some failed to gain full credit through a lack of required specific detail. Many referred to the speed of light being a maximum or saying that the particles reached a maximum speed without linking these ideas by actually stating that the particles approach the speed of light. Others were not clear in explaining the fixed time in the drift tubes or linking it to the constant speed to explain the constant length.

Q13(b)

This question also included assessment for the quality of written communication and many learners gained credit for a discussion of conservation of momentum in this situation, showing an appreciation of the principles involved. There was sometimes ambiguity in identifying which of the situations, colliding beams or stationary targets, was being described when they got to the stage of explaining the effect on kinetic energy. Having explained that more energy was available, many learners just linked this to a repetition of 'greater range of particles' from the question and did not explain that this was because particles of greater mass could be created.

Q14(a)

Learners were generally able to identify charging and discharging cycles from the graph, although a disappointing minority described the shape of the graph in terms of p.d. only rather than explaining it in terms of charge. Learners commonly went on to describe both parts of the cycle as exponential, which is not true for the charging part of the graph, so they were not awarded the second mark. This mark was most commonly awarded to those who quoted the charging equation for the first half of the graph as part of their answer.

Q14(b)

The great majority of the entry were awarded full marks for part (ii), the calculation of energy, often using the 'show that' value from part (i). Determining the capacitance was completed less successfully overall. All of the methods shown in the mark scheme were used, including 5*RC* which was accepted for this special case of full charge and discharge, although learners did no always justify their time constant. A minority forgot to subtract 1 second when deriving the time constant from the discharge curve or read off the time to increase to (4.0 V / e) from the charging curve.

A relatively common error was for learners to incorrectly assume charging with a constant current and use $V = IR$, $Q = It$ and $Q = VC$. This appeared to be based on the mark scheme for a recent paper rather than the paper the learners were actually sitting.

Q14(c)

Most learners who gained credit for this question did so by identifying the short time scale involved and, more rarely, the implication for the number of readings that could be taken. Learners also referred to the difficulty in taking simultaneous readings, but not always clearly enough to be awarded a mark. Some made generic comments about reaction time and instrument resolution that were not specific to this situation. A substantial minority answered a quite different question, seen in previous papers, about the advantages of data loggers.

Q15(a)

Learners generally appreciated the situation as involving electromagnetic induction and were frequently awarded both marks. Some answers lacked detail, for example not clearly linking induction and e.m.f. with statements such as 'induced current' or repetition from the question of 'an e.m.f. is produced'. Others referred only to wires cutting the magnetic field rather than referring to magnetic field lines or lines of magnetic flux. A significant group appeared to be thinking of a different situation by referring to a changing magnetic field.

Q15(b)(i)

Overall, learners had a good idea of how to approach this calculation, but a number of different errors crept into their work. These included not converting from cm to m, not squaring speed or angular velocity, omitting π from the final calculation and confusion over the time, such as using 27÷15 s rather than 15 s ÷ 27.

Q15(b)(ii)

The answers from part (i) were used appropriately by the majority to calculate minimum and maximum values of tension and most were able to plot them correctly. Learners less frequently appreciated the graph as one revolution in a continuous process and did not draw lines that would join smoothly with the previous and next revolutions of the wire.

Q15(b)(iii)

Learners usually approached by attempting to calculate the rate of change of flux as required, although a number of common errors were seen, some of these with mensuration, such as using $2\pi r$ or even $2\pi r^2$ for the area of a circle. The factor of 27 was not always applied to find the total area swept out.

Again, a group seemed to be thinking of a previous paper in their answer. They attempted to use the formula e.m.f. = Blv, which is not on the specification but was derived in the January 2018 paper and used there for moving wires in a motor, a different geometry. In this question it could be applied using average speed along the wire, i.e. dividing the speed at the end by 2, but that was very rarely seen.

Q15(c)

Very few amongst the cohort gained credit for this question, often suggesting the absence of a complete circuit of no change of flux linkage because of the angle to the magnetic field. Of those who thought of opposing e.m.f.s, many did not comment on their equal magnitude and so did not explain the observation.

Q16(a)

The majority of those gaining credit for this question did so by naming thermionic emission. While many associated electron emission with energy in some way, they did not include sufficient detail, such as mentioning emission form the surface of the metal. Many did not answer the question about the production of electrons in sufficient detail but explained the acceleration of the electrons to make a beam, as asked in a recent paper.

Q16(b)(i)

This straightforward calculation was tackled successfully by most learners, but some others were not sure how to proceed and used formulae from the sheet incorrectly, confusing V for p.d. with v for velocity and E for electric field strength with E for energy.

Q16(b)(ii)

Those learners who stopped to sketch a situation diagram of some sort were more likely to be among the small minority who were able to complete this simple calculation correctly. The great majority misinterpreted the situation, failing to appreciate that the horizontal component of velocity remained constant, and used sine, or occasionally cosine, instead of tangent.

Q16(b)(iii)

Most learners were able to complete at least part of this sequence of calculations. They often applied correct methods in general, but with incorrect velocities and distances. Although they had the vertical component of velocity they required, some tried to determine it from the original horizontal component, essentially assuming this was the resultant velocity as often assumed incorrectly in part (i). A number assumed that the electron travelled from exactly between the plates to the top plate before leaving, which was not stated in this question.

Q17(a)(i)

The majority of learners gained this mark by stating that a gamma photon has no charge. A substantial minority mad incorrect statements related to ionisation, such as 'gamma photons do not cause ionisation', which is not true for this ionising radiation, or superfluous statements, such as that they are not ionised. A number of learners attempted explanations for protons rather than photons.

Q17(a)(ii)

A majority of learners were able to relate the decreasing radius in the tracks to decreasing energy with appropriate justification, but the mechanism for the decrease in energy was less often identified clearly. Many learners suggested friction and others refereed to the electron and positron becoming ionised.

Q17(b)

Most learners applied $\Delta E = c^2\Delta m$, with errors seen including using proton mass, not multiplying mass by 2 and failing to square *c*. Many learners were able to complete the question using $E = hf$, but many others continued with inappropriate formulae as if the photon had mass and they were determining the de Broglie wavelength, using $E_K = p^2/2m$ and $p = h/\lambda$.

Q17(c)(i)

Learners did not often complete this correctly, more often treating a photon as a particle with mass and incorrectly using $p = mv$ with $v = c$ and then $E = mc^2$.

Q17(c)(ii)

Most learners were able to apply the formula from part (i) to successfully determine the photon momentum. Calculating momentum for the electron and positron was more problematic, with many using the same formula, $E = pc$, as for the photon, this time treating the electron as a massless particle. Errors seen when the correct approach was applied included using the mass of a proton and not doubling the momentum of the electron.

Some learners misunderstood the question and attempted to show that the interaction was inelastic.

Learners correctly determining the momenta generally, but not always, made a suitable comparative statement in conclusion.

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

- While past paper mark schemes can be useful revision aids, questions will not be identical so quoting them directly is unlikely to answer the particular question. Be sure to answer the question on the paper and not the question from a previous paper.
- 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.

- With wave-particle duality, be sure whether you are calculating wave or particle properties and remember that photons do not have mass.
- Physical quantities have a magnitude and a unit and both must be given in answers to numerical questions.
- When substituting in an equation with a power term, e.g. r^2, do not omit the index when substituting or forget it in the calculation.
- When working with vectors it can help to sketch the relevant triangles rather than try to apply them from memory.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

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