Examiners' Report
Principal Examiner Feedback

October 2017

Pearson Edexcel International Advanced Level Physics (WPH04)

Unit 4: Physics on the Move

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General Introduction

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 was the first October series sitting of the unit.

This was a relatively straightforward paper that allowed students of all abilities to demonstrate their knowledge and understanding of physics by applying them to a range of contexts with differing levels of familiarity.

Students 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 a choice of angle or deducing the charge of a nucleus.

They also knew some significant points in explanations linked to standard situations, such as 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 without particular reference to the 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, most definitions were given with all the required details 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. Students around the E grade boundary typically scored about 6 and A grade students 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	89
2	67
3	84
4	86
5	56
6	49
7	70
8	77
9	95
10	42

Section B

Question 11:

(a) The majority of students were awarded at least one of the marks of this question. Most were able to state that there was a centripetal force, but many did not associate this with the horizontal component of lift or mention a resultant force, rather suggesting that the centripetal force was a separate force in its own right. Similarly, it was often described as a force towards the centre of the circle, which is simply tautology, rather than being described as a force perpendicular to the direction of motion.

(b)(i) Nearly half of all students completed this proof satisfactorily, although quite a few started at $\tan\theta = (mv^2/r)/(mg)$ without a clear reference to either components or to a triangle of forces. Students trying to work back from the final answer rarely had any success as they could not show a link to $\tan\theta$.

(b)(ii) This straightforward calculation was completed successfully by the great majority. The most common error was to fail to square the speed when calculating the answer and after that the next most common error was incorrect algebraic manipulation. Some students did not gain full credit because they did not include a unit with their answer. A physical quantity must include a magnitude and a unit.

Question 12:

(a) Four fifths of the entry correctly identified the structure. Of those who did not, most identified the structure of a meson. Some students did not gain credit through imprecise language, for example writing 'three quarks and antiquarks' instead of 'three quarks or three antiquarks'.

(b)(i) Fewer than a third of the students scored on this question through a wide range of errors, from not identifying the correct charges to including incorrect particles or not knowing the symbol *n*. Some wrote their answer in terms of quark composition, but this did not match the required format indicated by starting with lambda.

(b)(ii) Just over half of the students gained a mark on this question, with a quarter being awarded two marks, the most common mark being for an indication of opposite directions. Some students merely stated conservation laws, often including those not requested, such as conservation of charge and lepton number. The conservation of energy was often discussed in terms of conservation of kinetic energy only, the link to mass-energy usually being missed.

(c) There was a fairly even spread of marks awarded for this question. Overall, the diagram marks were awarded more frequently than the explanation marks, the curvature being credited most often. A number of students missed credit for a statement of opposite charge because they only stated that anti-helium is negatively charged and did not compare it with the charge of a proton. The justification of the radius of curvature did not usually take into account both mass and charge.

Question 13:

(a)(i) Just over half of the students were awarded both marks but this could have been improved with more careful consideration of the question on the paper. The requirement was to measure current while a capacitor was charged through a resistor, so a power supply and ammeter were required as well as the named components. There was not a requirement to include a voltmeter. Errors included the omission of one or more of the required components, ammeters in parallel with the capacitor, switched circuits with the ammeter only in the discharging part and also failure to use the correct symbol for the capacitor.

(a)(ii) Just over half of students received both marks for this graph. About a third, however, got no marks because they drew either a charging curve or a straight line with positive gradient. Other errors included not starting with an intercept on the y-axis and meeting the time axis too steeply.

(b) There were a number of approaches to determining the capacitance, those most commonly seen being substitution of values from the graph into the exponential formula and the use of V_0/e to find the time constant. Some students did not make clear how they arrived at their value for the time constant and a number simply misread the graph. Well over half of students completed the question successfully.

(c) Many students used their value of capacitance with $W = ½ CV^2$ successfully, but some attempted to use ½ QV with a value of Q calculated from current, determined using V/R, multiplied by time.

(d) About half of students scored at least two marks, with nearly a quarter answering the whole question successfully. Students writing the correct logarithmic relationship went on to devise a number of suitable graphs, but a fair proportion missed the final mark because, although they stated the gradient correctly, they did not make the final statement that $C = 1 /(\text{gradient} \times R)$ or the equivalent for their graph.

Question 14:

(a) About a third of the entry completed all parts of the question successfully. Many students made errors in calculating the energy, using ½ mv^2 with $v = c$ or omitting 8000 or m_e or using the proton mass. A majority could apply $W = eV$ with their value of energy.

(b) Despite the specific reference to diffraction on the question, many students appeared to be answering a different question involving proton collisions to create new particles. They frequently referred to having sufficient energy to overcome electrostatic repulsive forces, for example. Those who attempted to answer in terms of diffraction often included insufficient detail and did not link the ideas included in their answers, for example getting the idea of small wavelength but not linking it to large momentum or to the size of the nucleons.

Question 15:

(a) The majority of students scored at least one mark, usually for a statement that an e.m.f. is induced because of a change in flux linkage. Students rarely stated that induced e.m.f. is proportional to rate of change of flux linkage. Indeed, failure to grasp the concept of rate was a limiting factor for a great many responses. Examiners reported that a number of responses referred to Lenz's law as if they were answering a question from a recent paper.

(b) Half of students gained at least three out of four marks, including starting at zero and showing a positive section and a negative section. Those with two relevant sections were fairly evenly divided in whether they got neither, one or both of the relative amplitudes and durations of the sections correct.

Question 16:

(a) A sizeable majority got at least two marks, usually for 'the atom is mainly empty space' and the idea of a concentration of mass in a nucleus, but there quite a few frequent errors. These included all of the charge being concentrated in the nucleus and the alpha particle or nucleus being empty space or the atom being empty.

(b)(i) The great majority got both marks for this question. Some got the atomic number and mass number the wrong way round and some gave a correct name with an incorrect description. While reference to the number of electrons was ignored in answers such as '79 is the number of protons and also the number of electrons' poor expression such as 'the number of electrons and protons' meant that some students could not be awarded a mark.

(b)(ii) Nearly half gained full marks, but a large minority did not gain marks through a variety of errors including using the Boltzmann constant for k, omitting the atomic numbers of gold and helium, using the mass numbers of gold and helium, omitting the electron charge or only using it once, not squaring the separation and using the electron mass instead of the electron charge.

Question 17:

(a) While about half of students appreciated that momentum was conserved only about a quarter explained how that applied to this situation and few went on to apply the idea of conservation of kinetic energy clearly. Many just gave a definition of an elastic collision. The most successful students used equations in their answers and made them clear by the inclusion of a zero term for the relevant coin before and after the collision.

(b)(i-ii) The great majority of students could apply the principle of conservation of momentum, but a number of errors were seen. These included using cos instead of sin and vice versa, resolving the same way for both parts, or failing to resolve at all for Q17(b)(ii).

Question 18:

(a) Most students got at least two marks, the most common error being to reverse the arrows, but many students would have gained a mark by using a ruler to carefully draw equally spaced lines perpendicular to the plates rather than the freehand attempts which were sometimes to inaccurate to credit.

(b) A sizeable minority of students scored full marks for this question which involved the successful application of five formulae in sequence, although about half failed to score at all. A number of students attempted to apply $F = qE$ but thought that E stood for energy and used $E = qV$ Others used $qV = ½\ mv^2$. Some used $F = mv^2 / r$ to find force. Like the use of Boltzmann's constant in question 16, this showed that some students rely on the formula sheet without being sure what each of the symbols represents, especially when the same symbol represents a range of quantities in different contexts. In some cases this approach to formula selection gave velocities many times the speed of light, but this did not lead to students correcting their answers.
Of those who calculated force correctly, most arrived at a correct value for acceleration but many stopped there, either because they thought that this was the required answer or because they didn't know how to proceed. A small minority of

students calculated the velocity with which the electrons left the electric field and gave this as their final answer, limiting themselves to the first four marks. The three distances quoted in the question were sometimes transposed during the question, although students using a small sketch to summarise the situation did not tend to have this problem.

(c)(i) Over half identified the correct direction, with the most common incorrect response being 'out of the page'.

(c)(ii) About half of students were able to tackle this question, with many others not appreciating the balance of forces on the electron. Despite the electric field strength being given in the question, some students used data from part (b) in their answers. A number of students failed to score the second mark through the omission of a unit or the use of an incorrect unit, such as Wb. While Wb m^{-2} was accepted on this occasion, compound SI units such as N A^{-1} m^{-1} are not accepted when there is a standard SI unit.

Summary

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

- Check that quantitative answers represent sensible values and to go back over calculations when they do not.
- 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 to know which symbols on the formula sheet represent which quantities, particularly where letters are used for more than one quantity, for example *E* and *k*.
- Explanations can often be supported by reference to formulae on the data, formulae and relationships sheet.
- 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.
- Physical quantities have a magnitude and a unit and both must be given in answers to numerical questions.
- When working with components it can help to sketch the relevant triangles rather than trying 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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