INTERNATIONAL A-LEVEL PHYSICS

(PH05) Physics in practice
Report on the examination

June 2019

REPORT ON EXAMINATION: INTERNATIONAL A-LEVEL PHYSICS (PH05) PHYSICS IN PRACTICE – JUNE 2019

Students tended to find section A easier than section B. Responses to questions involving data processing and experimental techniques seem to be improving. Many students could improve their graphical work even more by taking care and by being precise. Some students use awkward scales such as multiples of 3; this is penalised as are multiples of 7 and so on. When determining gradients, students should use widely separated points on their best fit line and should show construction lines such as triangles on their graphs. Students seem to be better at working with uncertainties although this element still puzzles some. Centres are encouraged to use the *Practical Handbook for A-level Physics* in order to confirm how such work is expected to be tackled. Students should leave answers to a sensible number of significant figures. In general, uncertainties are estimates and should have few significant figures, but in other calculations students should be guided by the number of significant figures in the supplied data.

Section B is particularly taxing for weaker students who struggle with the synoptic nature of some questions. It is in the nature of such questions to expect responses that require students to apply their knowledge in novel situations. However, more students seem to be coping well with questions of this type.

QUESTION 01

The set of calculations in 01.1 to 01.4 was well done by most of the students. Students were generally able to find percentage errors correctly and to aggregate them. It was pleasing to note that the general standard of presentation of calculations and of explaining the calculation process seem to be improving.

In 01.5, the majority of the students assessed the percentage uncertainty in the volume correctly. The most common error was to underestimate the absolute, and therefore the percentage error, by a factor of 2. This was a case where students may have been able to see better what to do by determining the maximum and the minimum possible values of the volume.

The majority of students answered 01.6 correctly.

QUESTION 02

In 02.1 most of the students made a sufficiently good attempt at drawing a best fit line for the unusually shaped graph. Students should note that several consecutive points are unlikely to be on the same side of the best-fit line and they should be encouraged to draw a single line rather than multiple lines.

Most students extracted data correctly from the graph in parts 02.2 and 02.3 but there was some misreading of the scales on the axes and some incorrect arithmetic in 02.3.

The majority of the students drew an acceptable tangent to the graph in 02.4 but sometimes tangents were on the rising part of the graph rather than the cooling section. A few others seemed to draw random lines that were clearly not tangential. It seemed as though some students were drawing lines that had gradients of 0.20 K min^{-1} in order to get the correct answer for the next part.

Part 02.5 was usually well done. Students should be reminded to use a large triangle for their determinations.

Although many students succeeded with 02.6, there was some poor data extraction to find the time taken for the temperature to reach a maximum. As there are two points at the same temperature at the peak of the graph, it is likely that the maximum occurs between those two points.

QUESTION 03

Question 03.1 was not answered well by many students. Few tried to draw a diagram involving a potentiometer to control the potential difference (pd) and most of those that tried could not draw a valid circuit. Most opted to use a variable resistor; this cannot control the pd over its *full* range.

Answers to 03.2 were much better. Students usually mentioned the need to measure the pd and the current, often specifying the use of the voltmeter and ammeter. Students found it harder to describe the way in which a suitable range of sets of results could be obtained and few mentioned the advisability of taking repeat measurements of each set of pd and current in order to find mean values. It should be noted that general statements that '*results should be repeated and averaged*' are not likely to attract reward: students should be specific about which measurements should be repeated. Many mentioned the correct formula for calculating the power and went on to suggest the use of a graph of P against I^2. Although many students suggested that such a graph is straight when the suggested relationship is correct, few mentioned that it goes through the origin.

QUESTION 04

Students did 04.1 well but a significant number did not compare the manipulated equation to $y = mx + c$.

In 04.2 most of the students performed the calculations correctly but few paid sufficient attention to significant figures. The significant figures in calculated values should, in general, be the same as for the data used in the calculation. In 04.3 students usually chose appropriate scales and plotting of points was usually sufficiently accurate. There was a tendency to draw the best-fit line by joining the first and last data points, possibly to generate easy data for the calculation of the gradient in the next part. This is poor practice as it produces a line that is not the best fit. Indeed, the practice of using data points to find a gradient should be discouraged. Gradients should be found from points that are genuinely on the best-fit line. There was a tendency in 04.4 for some students to use triangles that were too small. Many students are still reluctant to mark their triangles or other construction work on the graph and this often leads to loss of marks. Nevertheless, most students gained the majority of the marks for question 4 as a whole.

QUESTION 05

In 05.1 students could refer either to the reduced component of the velocity of the wind directed at the wind turbine generator (WTG) or to the effective reduction in area. A minority of students gave acceptable answers to this part. However, in part 05.2, most of the students realised that there would otherwise be risk of damage to the WTG.

The great majority of students did 05.3 well. It was pleasing to see that most of them also set out their work in a logical and clear way. A few students did not arrive at the expected answer because they used the rotor diameter in the calculation instead of the rotor radius.

05.4 was well done by many students but a large number confused peak and rms values and obtained an answer that was out by a factor of 2.

In 05.5, most students found one or two valid responses to do with work done against friction, or I^2R losses in the brushes or the additional need for maintenance. Comments that only mentioned friction without specifying a particular consequence or that mentioned better efficiency without explanation were not credited.

QUESTION 06

Most students gained some credit for their answers to 06.1. A good minority chose to explain what binding energy (BE) was. Few students related the magnitude of the energy released to the change in binding energy. Many students could explain that the binding energy or BE/nucleon increased during the fission process. Correct references to change in mass were also credited.

In 06.2, many students seemed unaware of the role of kinetic energy of the fission products and neutrons in transferring the energy released in fission. It was also evident in 06.3 that many students were not aware of the breakdown of energy released by fission and that some energy would not be available. In particular, the energy in neutrinos released in fission is not available for extraction. Other examples that were credited included mention of gamma rays or neutrons that may escape from the reactor or the subsequent radioactive decay of fission products (once fuel rods have been removed).

06.4 was done correctly by most of the students. The most frequent mistake was to use the 203 MeV value rather than the 180 MeV per fission that was available to the coolant.

There were some very good answers to 06.5 when students recognised that the pump would do work on the coolant, increasing its internal energy and that this energy would be subsequently recovered. A large number of students seemed to interpret the word '*pump*' as referring to pump-storage systems and so described these. A significant number did not attempt this part.

06.6 was well done by nearly all students.

QUESTION 07

In 07.1, the majority of students calculated the resistivity of the material correctly but a large number omitted the factor of 6 in the length of the conductor. The calculation of the stretched resistance of the gauge was usually calculated correctly in 07.2.

In 07.3, many students realised that an increase in the temperature would lead to an increase in the resistance of the gauge and an overestimate in the mass. Some mentioned thermal expansion of the gauge for which they received partial credit.

There were many good answers to 07.4. In the best answers, the students clearly set out their proofs and quoted equations that they needed before using them. There was some evidence that weaker students worked backwards from the given answer and had no clear idea how to proceed.

In 07.5, most of the students used the given equation to assess either the smallest mass that could be measured or the restoring current needed for a load of 1 μg. There were a surprising number of power-of-ten errors. Even when students performed the calculation correctly, many struggled to decide whether or not a mass of 1 ug could be measured.

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