Examiners' Report

Principal Examiner Feedback

October 2020

GCE Physics 9PH0 03

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Introduction

This paper consists of 120 marks split between short open, open-response, calculations and extended writing questions. The questions draw on a range of topics from the specification, and include synoptic questions drawing on two or more different topics. The paper also includes questions that assess conceptual and theoretical understanding of experimental methods (indirect practical skills), some of which draw on students' experiences of the core practicals.

This paper gave candidates the opportunity to demonstrate their understanding of a wide range of topics from the specification.

As with previous series, calculation questions gave candidates an opportunity to demonstrate their problem solving skills to good effect. Some very good responses were seen for such questions, with well crafted, solutions which were accurate and clearly set out. Occasionally in calculation questions the final mark was not awarded due to a missing unit. The limited use of the "show that" format in this paper may have increased the level of challenge for some candidates in questions where a calculation was required.

There were many examples of candidates disadvantaging themselves by not actually answering the question, or by not expressing themselves using suitable language.

Scientific terminology was used incorrectly in a number of responses seen on this paper. In particular candidates' use of the terms accuracy, error, precision, resolution and uncertainty seemed to be quite fluid, with some of these terms being used interchangeably throughout the paper, although Q1 which assessed candidates directly on their knowledge of the terms "accuracy" and "precision" generated a number of excellent responses.

The space allowed for responses was usually sufficient. However, candidates need to remember that the space provided does not have to be filled. Candidates should be encouraged to consider the number of marks available for a question, and to use this to inform their response.

If candidates either need more space or want to replace an answer with a different one, they should indicate clearly where that response is to be found.

Q1

This question was meant to provide a straightforward introduction to the paper, focusing on the key terms **precision** and **accuracy**. When scientists make an experimental measurement they assume that some "true value" exists, and that their measurements will produce a range of values that this "true value" will fall within.

Many candidates were able to identify a small spread of values as relating to a high precision, and a value close to the true value as being accurate. Some did this by defining accuracy and precision before relating these terms to the diagrams, and some expressed their understanding of the meaning of the terms through their references to the diagrams.

A common mistake was to identify the degree of accuracy and precision shown in each diagram without being specific about why this was the case.

Q2

This question is based on an experimental determination that should be familiar to most candidates, although they may not have recorded and analysed the motion of a falling object using video capture equipment.

(a)(i)

The best responses were clear about terminal velocity having to be reached before measurements were used to calculate the velocity, and they also indicated how we would know that terminal velocity had been reached.

Most responses mentioned some sort of averaging technique, and the vast majority stated how to calculate the terminal velocity. The time between frames was often omitted from the method, candidates presumably assuming that 60 frames s^{-1} would equal a time interval between frames of 1/60 s.

(a)(ii)

Parallax error was seen the most frequently, although some candidates stated that the frame rate may not be exactly 60 frames s^{-1}. As the command word was “explain”, it was expected that candidates would go on to state how this error would affect the velocity. Unfortunately most did not.

Some candidates misunderstood the question and wrote responses that stated general terms what a systematic error is.

(b)

Most candidates were able to state that there would be reaction time to take into account when using a stopwatch and stated that this would not be the case for the video recording. This was then often linked to a decrease in the uncertainty in the times measured from the video recording.

Some candidates referred to “human error” in using the stopwatch. This is **not** acceptable as an equivalent wording for “reaction time”.

Q3

(a)

A number of possible points could be made about the student's method, and most responses scored well on this item.

(b)

Although the simple pendulum should be familiar to all candidates, the method described here, in which the length of the pendulum was not measured directly was obviously unfamiliar to most candidates. Only a minority of candidates realised that the length of the pendulum could be replaced in the equation by the difference between the height of the support and distance of the bob from the floor.

Despite this, most candidates realised that the gradient would be the same as if the length of the pendulum had been measured directly, and so they were able to gain credit for their response.

Q4

This question is an extended writing question which assesses the candidates' ability to show a coherent and logical structured answer with linkage and fully sustained reasoning. There are 6 indicative content (IC) points, for which a maximum of 4 marks can be awarded. There are two further marks available for appropriate linkage of ideas.

It was disappointing to see that many candidates read the command sentence but not the preceding text. Therefore, in explaining how a sample of radium is able to release significant amounts of energy over a long period of time, it was common to see references to nuclear fission. Many candidates had missed the vital information that radium is radioactive with a half-life of almost two thousand years. Even those candidates who had read the half-life information often related this to a fission process.

The responses seen tended to indicate that many candidates were using vague ideas gleaned from GCSE physics, rather than considering the actual scenario presented to them in the question. The most commonly seen correct points were IC2, IC3 and IC4.

Q5

(a)

This is a straightforward calculation and most candidates scored full marks. Some missed out on the final mark due to a power of ten error.

(b)

This was generally well done, with most candidates coming to the correct conclusion as a result of a correct application of physics. A few candidates were unsure whether to add or subtract the 1.5 m, and some made no reference to this distance at all.

(c)

This was not as clearly answered as might have been expected. Many candidates referred to “current taking the path of least resistance” but failed to relate this statement to the actual situation.

Q6

(a)

The circuit was drawn well by most candidates. In some responses the voltmeter was placed in series with the heater, and in others the power supply was omitted.

(b)

This extended calculation required candidates to bring together a number of pieces of information to form a valid conclusion. It was well answered on the whole, although it was rare for candidates to fully justify their conclusion.

(c)

The experiment was obviously familiar to many candidates, and so many responses identified the use of lagging as a modification. Few went on to state why lagging would improve the accuracy of the student’s conclusion, as required by an “explain” question.

Q7

(a)

Many responses focused on a description of the process by which electrons are released from the source (the thermionic effect), rather than an explanation of how these electrons become a high energy beam. Of those responses that did answer the question, it was common to see a reference to an electric field without linking this to the potential difference.

(b)(i)

Most candidates correctly deduced that the magnetic field must be actin (perpendicularly) out of the page. Some candidates stated that the field must act into the page, possibly as a result of forgetting that Fleming’s left hand rule involves the direction of conventional current.

For the second mark to be awarded it was expected that candidates would give more detail than a bald statement that this was because of Fleming’s left hand rule. This was achieved by many candidates by a simple diagram that showed the directions of the field, force and (conventional) current.

(b)(ii)

Most candidates were able to state that the magnetic force would always be perpendicular to the direction of motion of the electrons. Fewer candidates referred to this causing an acceleration towards the centre of the circular path.

(c)(i)

This was well done by almost all candidates.

(c)(ii)

This was not well answered. Many candidates didn't know where to start with this calculation, beyond using the expression in (i) to calculate a value for the speed of the electrons. Those who could go further and apply some relevant physics didn't always realise that they were being asked to calculate the value of e/m. It was relatively common to see the value of m from the back of the question paper being used so that a value for e was calculated.

(d)

The rather obvious deduction that the hydrogen ion is about 2000 times more massive than an electron was missed by many candidates, who chose instead to make generalised statements about electrons or hydrogen ions that were unrelated to this particular experiment.

Q8

(a)

One question in this paper is used to assess candidates' ability to draw and interpret graphs. This may include using a logarithmic plot to test a power law variation as in this example.

Most candidates picked up both marks, being well drilled in this style of question. However, a small number were not able to simplify the equation using logs. The majority of those who obtained a correct log equation but missed out on MP2 did so by not making a clear link between their equation and the equation of a straight line ($y = m\ x + c$).

(b)(i)

In plotting a graph candidates should choose scales that spread the plotted points over more than half of the available graph paper. Difficult scales (i.e. scales increasing in "3"s, "7"s etc.) must not be used, and axes should be clearly labelled with units included which appropriate. Points should be plotted clearly (preferably using crosses) and a line of best fit drawn to show the trend.

Most candidates completed the table giving their data to 2 or 3 decimal places. A small number of candidates didn't realise that the extra column in the table was for the temperature difference. As in previous examinations in which a log plot has been required, most candidates were unable to show the label for the y-axis correctly.

(b)(ii)

Most candidates knew to use a large triangle when calculating the gradient of the line, and many obtained a value for m within the expected range. In most responses the unit for the gradient was either missing or incorrect.

(c)

This question required candidates to make a detailed consideration of the merits of using a data logger in place of a manual method of recording the temperature. The responses seen would tend to indicate that many candidates had learned some advantages of using a data logger without actually using a data logger themselves to collect data. Advantages of using a data logger seemed to be confined to the ease with which a data logger collects and processes data, rather than anything connected to the accuracy of the data obtained.

Q9

(a)

This is the second extended writing question which assesses the candidates' ability to show a coherent and logical structured answer with linkage and fully sustained reasoning. There are 6 indicative content (IC) points, for which a maximum of 4 marks can be awarded. There are two further marks available for appropriate linkage of ideas.

There were some reasonable responses to this question, with the first three IC points being seen most frequently. Most candidates realised that this was an example of resonance, although they often concentrated on the cone of the loudspeaker, rather than the air in the box.

(b)(i)

Most candidates realised that this was an example of a standing wave, although many thought that sand would be collecting in heaps at the antinodes. In reality sand is moved from the positions of the antinodes, and collects in heaps at the nodal positions.

(b)(ii)

Many candidates stated that the distance measurement should be taken over a large number of heaps. Hover, most stated that the distance measured should be divided by the number of heaps rather than the number of gaps between heaps.

(b)(iii)

This was a straightforward calculation, although many candidates were unaware that the heap spacing represented a distance equal to half a wavelength. These candidates either obtained a value for the speed of sound that was half the correct value, or randomly added a factor of 2 to their calculation to obtain a value close to 340 $m\ s^{-1}$.

Q10

This question assesses candidates' ability to calculate and combine uncertainties.

(a)(i)

All candidates were able to calculate the mean correctly, but a surprisingly large number of candidates rounded their answer to the nearest mm.

(a)(ii)

In most responses the half range value was used, although some candidates used the greatest deviation from the mean value. Either method is correct. Some candidates used half a scale divion for this calculation, which is incorrect.

(a)(iii)

This was well answered, with most counting 18 loops, but some using 16. Either method could gain full marks.

(b)(i)

Most candidates identified a micrometer (screw gauge), but only some justified this on the basis of the value given having a resolution of 0.01 mm. Some candidates chose Vernier calipers or just calipers, neither of which was acceptable. Digital calipers, which are now used in a number of schools, was accepted as a correct alternative to a micrometer.

(b)(ii)

Although most candidates correctly used half the resolution of the instrument, some used the full resolution.

(b)(iii)

Most candidates obtained the correct answer. However, some candidates used 0.05 g for the uncertainty in the mass, even though it was clearly stated that the mass was 32.0 ± 0.5 g.

(b)(iv)

All candidates realised that the various uncertainties had to be added together to calculate the overall uncertainty. Some forgot to double the percentage uncertainty in the student's value for *d* (this is because *d* is squared in the calculation for the volume of the spring).

(b)(v)

Most responses got as far as a value for the density of steel. Some candidates used their value of the overall uncertainty from (iv) to identify an upper value for the density in order to allow a conclusion to be drawn. Some just compared their density value with 7 800 kg m^{-3}, and calculated a percentage difference.

Q11

(a)

This calculation was generally dome well. In responses that did not score full marks it was usually due to *T* not being raised to a fourth power, or *d* not being squared when the calculation was carried out.

(b)(i)

A reasonable number of responses were seen in which the effects of reflection from the top of the atmosphere and absorption as radiation passes through the atmosphere were identified as reasons why the average intensity of radiation from the Sun at the Earth's surface is much less than the intensity incident at the top of the Earth's atmosphere.

However, many candidates then focused on the tilting of the Earth's axis and tried to argue that this meant that light had travelled further to get to the poles than to arrive at the equator. Although this is true, the extra distance is negligible compared with the distance from the Earth to the Sun. The key effect resulting from the tilt in the Earth's axis is the angle the incident radiation makes, and the "length" of atmosphere that the radiation must pass through in order to arrive at the surface of the Earth.

(b)(ii)

Although this question required some careful thinking, it was well answered by a good number of candidates. A common way in which to arrive at the wrong answer was to use an incorrect expression for the surface area of a sphere.

(c)(i)

Some candidates referred to the orbit as being geosynchronous without really spelling out that this means that the satellite would be in the same position above the Earth's surface at all times, hence enabling continuous contact to be made with the satellite at all times.

(c)(ii)

This question was well answered, with most candidates being able to recognise the gravitational force as a resultant force and apply Newton's second law to obtain a correct value for the orbit radius. Unfortunately, a number of candidates forgot to subtract the radius of the Earth to obtain a value for the height of the satellite above the Earth's surface.

Paper Summary

In order to improve their performance candidates should:

- Ensure that they have a thorough knowledge of the physics content of the whole specification.
- Be ready to apply their knowledge of core practicals and general techniques to questions testing their indirect practical skills.
- Read each question carefully, and answer what is asked.
- Show all their workings in calculations.
- For descriptive questions:
    - Make a note of the marks and include that number of different physics points.
    - Try to base the answer around a specific equation or principle.