GCSE

Rewarding Learning

Chief Examiner's Report

Physics

Summer Series 2023

Foreword

This booklet outlines the performance of candidates in all aspects of this specification for the Summer 2023 series.

CCEA hopes that the Chief Examiner's and/or Principal Moderator's report(s) will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This booklet forms part of the suite of support materials for the specification. Further materials are available from the specification's microsite on our website at www.ccea.org.uk.

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GCSE Physics

Chief Examiner's Report

Subject Overview

Prescribed practicals

The Covid pandemic appears to have impacted on candidates' opportunities for developing Physics practical skills. In Booklet B (GPY32 &34) many candidates struggled with the Hooke's Law experiment. Many candidates did not know how to convert a mass in grammes to a force in Newtons or to calculate the extension of the spring from length measurements.

Physics equations

Candidates are always advised to show clearly how they get their answer, starting with the equation they plan to use. Although, a numerical answer is correct examiners will check if the appropriate physics equation is present. A wrong physics equation leading to a correct numerical answer will lead to no marks.

As pointed out in a previous report there appears to be a growing trend of candidates presenting their own versions of physics equations rather than the ones stated in the specification. Equations written in terms of units for a quantity as well as triangular memory aides will not be credited unless the proper equation is shown.

Graphs and units

Many candidates gained marks by plotting and drawing a graph. While the advice of using the using the notation ⦿ or X, has been adopted by some candidates, too many fail to follow the advice. Centres should encourage candidates to adopt this approach and the labelling of axes on graphs using the solidus notation.

Presentation

The poor quality of handwriting is an ongoing issue. If an examiner cannot read the response, they cannot give any credit. Additionally, if a candidate does not want part of their work to be marked, they should clearly indicate this, by putting a line or two through their work.

Assessment Unit 1 Motion, Force, Density and Kinetic Theory, Energy, and Atomic and Nuclear Physics

Foundation Tier

Overview

The entry for this paper was 50 with a mean mark of 42.3, the maximum mark was 80. The number of candidates entered for this unit was significantly lower than in previous years. The range of marks tended to follow the same pattern. As always, many candidates, at the lower end of the mark spectrum, find the conceptual nature of Physics challenging.

Candidates should take notice of instruction on the examination paper "Show clearly how you get your answer, starting with the equation you plan to use". This would ensure the award of partial credit.

Q1 **(a)** **(i)** The majority of candidates made a good attempt at this question.

(ii) The calculation of average speed often saw the use of s = d/t which was incorrect physics in this context.

(iii) The unit for rate of change of speed was often incorrect and the final speed was sometimes quoted as '4'; perhaps mistaking the time value for speed.

(b) **(i)** The use of s = d/t was correct but too often candidates failed to read data accurately from the graph and failed to achieve full credit.

(ii) Many candidates did not know that speed was represented by the gradient of the graph.

(c) **(i)** Descriptors of the motion were varied and sometimes lacked appropriate detail to achieve credit.

(ii) Too often candidates used the equation s = d/t to calculate the distance, which was incorrect physics, as opposed to the area under the graph.

Q2 **(a)** **(i-ii)** These parts were generally well answered. However, many candidates failed to give 'Weight' as the downward force.

(iii) Generally, the resultant force was calculated correctly but many incorrectly gave the direction as 'west.'

(iv) The use and knowledge of the equation F = ma was not well known; too often a = m/F was used. Centres might wish to focus attention on rearranging equations.

(b) **(i-ii)** Perhaps as a follow on from Part (a) the equation F = ma was too often offered as a way to calculate the moment of a force, despite this many proceeded to use the principle of moments correctly in Part (ii).

(c) **(i)** In most instances, candidates achieved at least partial credit by stating the relation as proportionality but omitted to mention that this only applied 'up to the limit of proportionality'.

(ii-iii) In some cases the extension caused by 1N was incorrectly calculated but the unstretched length was correctly done.

Q3 **(a)** A variation of incorrect answers was noted. Many candidates failed to recognise the fact that wood would have a larger volume.

(b) **(i-iv)** In many instances the kinetic theory descriptors for solids, liquids and gases were not well known, leading to vague responses.

(c) **(i)** Calculating the volume of the block was well done.

(ii) The density calculation often gained full credit or at least partial credit but in a few scripts the equation D =M/V was not known or an incorrect variation used such as, D= V/M.

Q4 **(a)** While, generally the output energies were accurately named the output energies were not.

(b) **(i)** There was a range of statements for the Principle of Conservation of Energy given, many of which were acceptable.

(ii) Most candidates showed an appreciation of the meaning of Efficiency and knew the equation for calculating it. Many incorrect versions of equations were given. However, most candidates correctly calculated the useful kinetic energy output as 720J and gained some credit.

(c) **(i-ii)** The equations for calculating potential and kinetic energies were either well known and worth full credit or not and awarded zero marks.

(d) Very few candidates gained the full 6-marks for this QWC question. Responses were often too vague and failed to use appropriate scientific terms.

Q5 **(a)** **(i-ii)** Knowledge of atomic structure was generally well known with most candidates achieving full or partial credit. However, there was some confusion between protons and neutrons. Which led to incorrect responses in Part (ii).

(b) **(i-ii)** Overall, the names and nature of nuclear radiations was well known although. Some candidates stated X-rays and microwaves.

Higher Tier

Overview

The entry for this paper was 2979. The mean score was 70.8 out of 100 marks, compared with the mean score in 2022 of 70.4.

Q1 **(a)** **(i)** Many candidates did not recognise velocity as a vector quantity.

(ii) Most candidates knew that a displacement of zero for one lap of the race circuit produced an average velocity of zero.

(b) **(i)** The calculation of constant speed given distance and time was well done by most candidates.

(ii) As in the previous part, the calculation of average speed as the car braked was well done.

(c) When converting km/h to m/s most candidates displayed their method in a logical and easy to follow way. Some candidates converted from m/s to km/h which was an acceptable approach.

(d) **(i)** The calculation of average speed using values from the distance-time graph was well answered. A small number of candidates did not read the graph correctly but gained partial credit for outlining the method they intended to use.

(ii) Most correctly identified the times when the graph showed the period of slowest speed and gave a correct explanation for their answer.

(e) **(i)** Many candidates correctly used the area under the graph between 0 and 16s to find the height of the drop tower. A few used the area of the falling portion between 18s and 24s to correctly do this.

(ii-iii) Most candidates correctly gave the times when the drop took place and the brakes were applied.

(iv) Most candidates who used the gradient of the velocity time graph to calculate the acceleration gained full marks. Those who used the equation of motion to do the calculation often confused their signs for initial and final velocities and lost marks.

Q2 **(a)** **(i)** Most candidates correctly calculated the resultant of two forces. However, some candidates gave the direction as north, west etc. and received no credit.

(ii) The use of F = ma to calculate acceleration was well done. Some candidates were unable to re-arrange the equation correctly to determine the acceleration.

(b) A simple problem on the Principle of Moments that was well done by most. However, candidates should be encouraged to display their work, in this case, to show that the clockwise and anticlockwise moments are equated. This gives candidates a chance to gain partial credit if they make a mistake in final calculation.

(c) **(i)** Most candidates gave a complete statement of Hooke's Law. Those that did not failed to mention the limit of proportionality. Some stated the limit of elasticity for which they did not gain credit.

(ii) The determination of the extension produced by a 1 N force was very well answered.

(iii) Most candidates coped well with the calculation of the spring constant. However, as with other questions the re-arranging of F = ke was challenging for some candidates. Giving the unit of the spring constant as N cm was a common mistake.

(d) The calculation of force on the rubber suction cap was well done. The re-arrangement of P = F/A to calculate the force was a problem for some candidates.

Q3 **(a)** A surprisingly large number of candidates failed to realise that 1kg of wood would have a larger volume than 1 kg of lead.

(b) **(i)-(iv)**The understanding of the kinetic theory of matter continues to be an area of weakness for many candidates. Responses related to the properties of solids, liquids and gases were often vague and inaccurate and not mark worthy.

(c) The calculations of volume and density were well done.

(d) The use of the graph to identify the blocks made of the same material was generally well answered. Many candidates calculated the density of all the blocks. The use of the linear relationship between volume and mass would have been simpler.

Q4 **(a)** The QWC question examined candidates' knowledge of heat transfer in heating a home. Most candidates knew the three methods of heat transfer. However, many were unsure about the process of heat transfer through a radiator. A few stated that electrons in the metal radiator were the particles responsible. Many candidates gave a detailed description of how a room heated when they could have just stated convection. The role of the shiny metal foil in reflecting radiant heat was not well known. A variety of materials used in cavity wall insulation was named and most gained credit. However, convection instead of conduction was often given as the method of reduced heat transfer. Double glazing was also incorrectly identified as reduction of heat transfer by convection instead of conduction. Placing a carpet on a concrete floor to reduce heat loss did not occur to many candidates.

(b) **(i)** Many candidates gained full marks for completing the energy flow diagram for the hydroelectric power station.

(ii-iii) Most were able to calculate the potential energy in Part (ii) but a few found difficulty in realising that this was also the input energy. Many were unable to convert the input energy from watts to megawatts.

(iv) Many candidates gained full marks in the calculation of efficiency. Allowing an error carried forward from earlier parts enabled candidates who had clearly shown how they obtained their answer to gain full marks.

(c) **(i)** Most candidates used to graph to correctly determine the energy lost as the ball rolled down the slope.

(ii) This was a question for most candidates. Only the more able candidates correctly used work = force x distance to determine the friction force between the ball and the slope.

(iii) Many candidates correctly used the formula for kinetic energy to calculate the speed of the ball when it reached the bottom of the slope.

Q5 **(a)** **(i)** While most candidates identified the thin gold or metal foil, very few correctly named the detector part of the apparatus.

(ii) Only a few candidates knew the reason why a vacuum was required inside the apparatus.

(iii-iv) Most knew that the passage of alpha particles through the atom indicated that the nucleus was small and that their deflection was evidence for a positively charged nucleus.

(b) **(i)** The radioactive decay equation for alpha decay was well done with most candidates gaining full marks.

(ii) Many candidates were unable to clearly explain that background was the activity with no identifiable source present. Although, most candidates knew background activity was used to correct for the measured activity.

(iii) Most candidates identified the 11.4 days as three half-lives and correctly completed the calculation.

(iv) Most candidates correctly described Ionisation as the removal of electrons.

(v) Most candidates knew why ionising radiation is a danger to humans.

Assessment Unit 2 Waves, Light, Electricity, Magnetism, Electromagnetism and Space Physics

Foundation Tier

Overview

The entry for this paper was 84 compared with 96 in 2022. The mean mark was 36.6 from 80 marks, it was 41.9 in 2022.

The number of candidates entered for this unit was lower than in previous years but the range of marks tended to follow the same pattern. Again, as in previous years, this unit appears to be more challenging for candidates. As in the past candidates at the lower end of the ability range appear to find the conceptual nature of the subject challenging. Candidates should be encouraged to observe the instruction on the paper "Show clearly how you get your answer, starting with the equation you plan to use". This would help to ensure the award of partial credit. In some scripts the quality of handwriting was poor.

Q1 In general this question was well attempted.

(a) Responses were good but in Part (i) many candidates provided vague responses and failed to accurately identify the direction of movement for the string.

(b) Most candidates gained at least partial credit but in many scripts the answers lacked detail.

(c) Generally, regions of the em spectrum and associated order of wavelength were well known. However, common incorrect responses for Part (iii) were microwave and for Part (iv) skin cancer.

(d) Many candidates did not gain the full two marks for this part of the question by failing to state, the emission of a pulse and its detection after reflection by the fish.

Q2 **(a)** A few candidates gained full credit but a significant number could not identify the angles i and r on the diagram but managed to calculate their values or vice versa.

(b) The diagram for Part (i) was well known but not for Part (ii) with many displaying refraction as the ray left the block.

(c) **(i)** Completion of the diagram for dispersion of light by the prism was poorly answered. Many candidates failed to show dispersion at the first prism face, instead indicating that it occurred at the second face. Some candidates showed incorrect refraction directions.

(d) Some candidates did not correctly draw and label the image to show its position.

(e) The ray diagrams for short sightedness and its correction were either well known or not. Candidates lost marks for failing to show in Part (i) convergence in front of the retina and in Part (iii) divergence after the correcting lens despite correctly identifying the type of correcting lens for Part (ii).

Q3 **(a)** The concept of free or delocalized electrons in conductors was very much in evidence.

(b) **(i)** Generally, the calculation of the resistance was well attempted. Some candidates did not provide an equation and failed to achieve partial credit.

(ii) Calculation of the power of the lamp was either well attempted or not Evidence of P = I x V gained partial credit.

(iii) Finding how long the cell would last proved a challenge for many but with an error carried forward from Part (ii) some candidates did achieve partial or full credit.

(c) **(i-ii)** The presentation of parallel and series circuits as lamps rather than resistors was a challenge for some candidates. In several instances the same value of resistance was quoted for both circuits.

(iii) Identification of circuit 1 as having the brighter lamps appeared to have been difficult, perhaps not surprising given some responses to circuit resistance.

(iv) Many candidates lacked understanding of the relationship between resistance and current and the calculation of the current flowing in circuits 1 and 2 for many was based on guesswork.

(v) While most candidates gained partial credit for mentioning collisions, many failed to state that the collisions were between electrons and atoms in the filament. Many candidates gave the cause of heat in the filament as friction which was not mark worthy.

Q4 **(a)** **(i-ii)** Naming of a source of a.c. and d.c. was considered to be a simple two marks but the responses were frequently unacceptable e.g. CRO and generator.

(iii) Explanation of the difference between a.c. and d.c. lacked accuracy and often failed to mention that a.c. continuously, frequently or periodically changed direction.

(iv) The CRO display for a.c. was well known.

(b) This QWC question was poorly answered by most candidates. This suggested that candidates lacked understanding about electromagnetic induction. It was hoped that candidates would have experienced practical work or seen a laboratory demonstration for this concept. The explanation of em induction in terms of a changing magnetic field was almost absent. Many stated that the soft iron core was a conductor which allowed current to flow between the coils. Descriptions of the observation of the ammeter often referred to the coils heating up. Very few candidates referred to the momentary deflection of the meter and returning to zero. Reference to the ammeter deflection changing direction to the opposite when answering points three and four was rare. A reasonable number of candidates gained credit for knowing the transformer as the device used in the transmission of electricity.

Q5 Overall, this question was well answered but explanations of what the red shift meant in Part (b)(i) were weak. Some candidates made reference to the Doppler Shift which is well beyond the specification.

Higher Tier

Overview

The entry for this paper was 2665, in 2022 it was 2598. The mean for the paper was 71.4, the maximum mark is 100. The mean in 2022 was 72.8.

The overall standard of answering in this unit was good. Candidates' responses to questions which tested knowledge of practical activities suggested that most candidates had experience of practical activities although in some cases the students' experience of hands-on practical work has been limited.

Many candidates did not present mathematical solutions in any logical order. The question paper makes it clear that candidates are advised to show their working out and that they should start with the equation they plan to use. Unfortunately, many candidates ignored this advice. As mentioned in last years' report, the quality of handwriting, in some cases, was very poor. This makes it difficult for examiners to award marks when they can't recognise what the candidate is trying to convey.

Q1 **(a)** **(i)** Most candidates correctly used the displacement-distance graph to find the wavelength of the wave.

(ii) Finding the frequency of the wave from the displacement-time graph and giving the unit was well done by most students.

(iii) This item involved recall of the wave equation and using it to determine wave velocity. For those who knew the wave equation this was a simple task. A small minority attempted to use speed = distance/time and while some could use this equation successfully many could not.

(b) Most candidates successfully recalled how the wavelength changes when a wave moves from shallow water to deep water.

(c) **(i)** Most candidates knew that ultrasound has a frequency above 20 kHz.

(ii) This question on the detection of a crack in a railway track was poorly answered by almost all candidates. Candidates ought to have realised that a simple response linking A with the top of the rail, B with the crack and C with the bottom of the rail was all that was required.

(iii) This item was an application of the echo principle. The candidate had to recognise that the time for the ultrasound to make the round trip was 2 microseconds. They then had to use standard index form in their calculator. Most candidates coped well with the calculation, but many forgot to divide their calculated distance by two. The most common incorrect response was 0.0118 m.

(d) Most candidates knew the names of the electromagnetic spectrum and scored full marks. Some gave the names in the reverse order. A small number confused ultrasound with ultraviolet radiation.

(e) Most candidates knew the differences between electromagnetic radiation and sound. A few wrote that em radiation travels at the speed of light. This information was given in the question and received no credit.

Q2 **(a)** **(i)** Most candidates completed the diagram to show the passage of a ray of red light and a ray of violet light through the prism and into the air. A few candidates lost marks by showing violet light being refracted more than red light. Others lost marks by showing refraction towards the normal when the ray passed from glass into the air.

(ii) Most candidates knew that all colours travel more slowly in glass than in air. Few candidates were able to say that different colours experience a different change in speed.

(b) **(i)** Most correctly identified the conditions needed for total internal reflection. However, inaccurate use of language caused many to lose marks. For example, phrases like "the ray has to be less than the critical angle" were not credited.

(ii) The passage of the ray through two right angled prisms was well done by almost everyone.

(c) **(i)** Most candidates correctly identified the position of the principal focus on the ray diagram.

(ii) Most were able to draw the ray diagram to locate the virtual image. However, candidates were also required to draw the image and examiners expected a vertical arrow from the principal axis to the point of intersection of the virtual rays.

(iii) Most candidates correctly stated the properties of the image.

(d) **(i-ii)** Those who had carried out the experiment to find the focal length of a lens had no difficulty with this item. However, some candidates thought the focal length was the distance from the tree to the lens.

(iii) Almost all candidates knew that reliability could be improved by repeating and averaging results.

(e) **(i)** Most candidates correctly identified the lens as diverging or concave.

(ii) Almost all candidates showed rays diverging upon leaving the concave lens and then converging to the retina at the back of the eye. A small minority of students did not know that a concave lens causes a parallel beam of light to diverge.

Q3 In general, this question was well answered by most candidates. However, this was one of the more mathematical questions on the paper. It is worthwhile emphasising that candidates are advised to show their working, if they are to maximise their marks. The order in which they should proceed is equation, substitutions, calculation. Setting out work in this order allows the candidates to see and correct any error quickly and allows examiners to award partial credit where appropriate.

(a) **(i)** Most candidates correctly calculated the total resistance of the circuit. Some misquoted the formula and others forgot to take the reciprocal of 1/ Rt.

(ii) Most candidates correctly applied Ohm's Law and gained full marks.

(iii) While many gave the correct answer by using V = IR, some were hopelessly lost.

(iv) Some candidates arrived at the correct answer by realising that the voltage across each of the parallel resistors was 1.8 V and applying Ohm's Law. Others knew that the current in the 6 ohm and 3 ohm resistors split in the ratio 3:6. A significant minority appeared not to know where to begin.

(b) **(i)** Almost all candidates correctly identified the 1.35 ohm result as an anomaly.

(ii) Most candidates saw the need to keep the length constant to ensure a fair test.

(iii) Many candidates recognised that the relationship given showed inverse proportion and the product RA in the table was (approximately) constant, except for the anomaly.

(iv) This item was well answered by almost all candidates. For some, one difficulty was recognising that the unit for k was Ω mm2. Some lost this mark by inserting a solidus and writing Ωmm2.

(c) (i) This calculation using the power equation, P = IV, to find the maximum current was generally well done. A few candidates lost marks by misquoting the equation or failing to apply it correctly. Others appeared to guess that a dishwasher used a 13 A fuse.

(ii) Those who could calculate the total number of kWh used generally went on to obtain the correct answer. Some candidates failed to notice the power of the dishwasher was given in the diagram.

Q4 (a) This QWC question was well answered. Many candidates scored full marks. Some had fundamental misunderstandings about electromagnetic induction. For example, a significant minority thought an iron core was used because it was a good electrical conductor. Others thought that when the switch was left closed the ammeter continued to show a current.

(b) (i) The use of the turns-ratio equation to find the number of turns in the secondary coils was very well done. However, this was also an example, where some candidates did not clearly show their method.

(ii) Most candidates knew some of the differences between AC and DC, although some failed to convey that in AC the current regularly reverses direction.

(c) (i) Almost all candidates knew that the direction of the magnetic field was from North to South.

(ii) This question was poorly answered by many candidates who appeared simply to guess. Some thought the force on AB was up while that on CD was down. There was little in common among the other incorrect answers.

(iii) Most knew that the forces on the long sides of the coil made it rotate. It was disappointing that they did not notice that their response was inconsistent with that to Part (ii).

Q5 (a) (i) Most knew the meaning of the term light-year.

(ii) This question was generally well answered. A few candidates failed to notice that the distance given was in km which led to a power of ten error in answers. Once again, it should be stressed those who did best in the question tended to set out their work with greater care.

(b) (i) While this question was generally well answered, several candidates thought that a galaxy was a place in space. It is not. The simplest answer is that it is a collection of stars.

(ii) Most candidates knew that the observation supporting the expansion of space is red shift.

Assessment Unit 3 Practical Skills

Foundation

This unit comprises Booklet A (GPY31) worth 30 marks combined with Booklet B (GPY32) worth 70 marks. The mean score was 55.9 compared with 64.2 in 2019.

Unit Overview

The number of candidates entered for this Practical Skills paper was significantly smaller than previous occasions, with an entry of only nine candidates. In general, candidates performed well in these papers.

Experiment 1

(a) Most candidates obtained a complete set of readings of the time taken for the ball to roll down the ramp. However, some candidates failed to complete the table headings, sometimes they omitted a unit or did not provide all the recorded times to one decimal place as required.

(b) **(i)** Average times were usually calculated correctly but in some instances, not quoted to one decimal place, as required.

(ii) The equation for calculating average speed was well known and its use to find the average speed well performed, if not always to one place of decimal.

(c) **(i-ii)** Generally, the scale chosen by candidates for the Average Speed axis was good and covered most of the grid. Points plotted on the grid were clear as was the best fit curve. However, some candidates had difficulty drawing a smooth continuous curve and resorted to joining points with short lines.

(iii) Most candidates circled No to indicate the graph was not one of proportion and qualified their choice by stating the graph was a curve.

Experiment 2

(a) Generally, candidates inserted the ammeter correctly into the circuit and obtained a full set of readings for Voltage and Current. The table headings were usually completed correctly. In several instances candidates recorded values of voltage from the voltmeter but added 1V, 2V 6V outside the table and used these for their analysis in Parts (b) and (c). Using these numbers for the calculated values was not accepted, as they were not the recorded values in the table.

(b) In general, the graph axes scaling and labelling was good but there were several occasions when non-uniform scales were used and a unit was absent from the labels.

(c) Several candidates appeared to recognise the equation V = KI as Ohm's law and gained full marks for this part. By selecting the correct answer of Yes candidates were expected to explain their choice by stating that the graph was a straight line which passed through the origin. In Part (iii) the unit for K was not always given. Many candidates gave a correct explanation for Part (iv).

Booklet B

Overview

As was the case for GPY31 (Booklet A) the number of candidates entered for this paper was significantly smaller than previous occasions. Overall, candidates performed, slightly, less well than might have been anticipated but with the low number of candidates it is difficult to make meaningful comparisons with practical papers from pre COVID years. When plotting graphs, candidates should be encouraged to clearly mark their points using either an X or a circled dot ⦿ as instructed in the question.

Q1 **(a)** This was well attempted but Parts (i) and (iv) were surprisingly poorly answered by some.

(b) Completion of the table was generally good but a few candidates failed to successfully calculate the extension values.

(c) **(i)** Candidates should be encouraged to clearly mark their points on the graph using either an X or a circled dot. The extension axis was clearly labelled, a good scale was used and a best fit line drawn.

(ii) Partial credit was gained by most candidates for recognising k as the gradient of the graph or rearranging the equation but too often the unit mark was lost.

(iii) As for Part (ii) most gained partial credit but accuracy to ensure a doubled gradient on the graph proved to be a pitfall for a good few.

Q2 **(a)** **(i)** The completion of the table was not as straightforward for some candidates sometimes failed to achieve the three marks available and some, gained no marks at all.

(ii) Most candidates gained partial credit. However, many failed to recognise that the 2N weight could only create a moment of 100 Nm when placed at the end of the rule which was less than the 160 Nm created by the 4N weight.

(b) **(i)** The conceptual nature of the centre of gravity challenged some candidates. Marking its location on the rule provided a range of unacceptable answers.

(ii) Many candidates confused the weight of the object with that of the rule and
offered anti-clockwise as the direction.

(iii) Calculating the weight of the object was a demanding task for most candidates. This tended to confirm that candidates found the concepts of C of g and the “Invisible Force” acting challenging.

(iv) For full credit candidates had to use the idea of repeating the procedure and finding an average value.

Q3 **(a)** **(i-ii)** The candidates’ use of correct circuit symbols for the ammeter and rheostat and their descriptions of how they were used to keep the current constant were commonly poor.

(b) **(i)** While most candidates correctly labelled the graph a number of candidates transposed incorrect data values on the graph scales. However, all candidates gained at least partial credit. Candidates should be encouraged to clearly mark their points on the graph using either an X or a circled dot.

(ii) Most candidates achieved at least partial credit, including those who had transposed incorrect data by ‘error carried forward’ being applied.

(c) Many candidates failed to recognise that this was a new or different investigation and provided responses relevant to that in Part (b). A good number of candidates also failed to demonstrate an adequate understanding of Dependant, Independent and Controlled variables and did not gain the full six marks available for Parts (i) – (iii).

(iv) When a candidate selected a graph as representative of the data provided, they also provided an acceptable explanation.

Q4 (a) (i–iii) Generally, candidates' responses were credit worthy although, some lost marks by failing to give calculated averages to one decimal place as required.

(b) (i–iii) Many candidates performed well with graph work, labelling and scaled axes. However, often best fit lines were poorly drawn and not as a defined single line. Most candidates correctly calculated the graph gradient by selecting their own 'rise and run' values.

(c) Extraction of data from the graph was usually accurate and explanations of why it did not display proportionality were acceptable.

Higher Tier

This unit comprises Booklet A (GPY33) worth 30 marks combined with Booklet B (GPY34) worth 70 marks. The entry at Higher level was 2750. The mean score was 84.4 compared with 76.1 in 2019.

Overview

In general, candidates performed very well in this practical paper. Most candidates obtained data that could be processed to valid conclusions. Graph plotting skills were sound with very few candidates transposing axes or failing to label axes correctly. Candidates should plot points, as suggested with an x or a dot and circle. On occasion the best fit line obscured the points if not plotted using the correct symbol. Calculations were generally well displayed. There was no evidence that candidates found time limitations challenging, all candidates attempted all the parts. The language used in the paper was at an appropriate level for a GCSE candidate.

Experiment 1

(a) (i) Most candidates were able to head the columns appropriately. Not all candidates used the solidus with the unit, although there was no penalty for this. All candidates provided three timings for the ramp height of 1cm.

(ii) Most candidates provided appropriate timings for the ramp height of 2cm.

(iii) Most candidates provided appropriate timings for the remaining ramp heights. However, many failed to present the data to 1 decimal place.

(b) (i) Generally, the average times were accurately calculated, although some candidates rounded incorrectly.

(ii) Most candidates offered a workable equation. The better candidates used velocity and displacement, but many candidates used distance and time which was credited. A small number of candidates did not give a full equation and failed to gain the mark. Most candidates were able to calculate the average velocities accurately.

(iii) Most candidates calculated the final velocities correctly, but a fewer number of candidates observed the two decimal place criteria.

(c) **(i)** Most candidates labelled their axes correctly. Only a very small number failed to do this. Most candidates chose appropriate scales and accurately plotted points. Some candidates failed to label using a solidus and plotted points using a single dot which was often obscured. Although, this was not penalised.

(ii) Most candidates drew a smooth curve through their points and gained credit.

(iii) This question provided some discrimination between candidates. Only the more able candidates correctly identified the correct relationship and gave a meaningful explanation.

Experiment 2

(a) **(i)** Many candidates failed to be awarded the two marks for completing the circuit as indicated by their teacher ticking the front cover of their script. It was impossible to distinguish between those scripts where the teacher intentionally left the box unticked or not.

(ii) Generally, the columns were suitably headed, although often with brackets or spaces rather than the more appropriate solidus. Some candidates did not give the correct unit for current, giving Current/I.

(iii) All the Candidates recorded values of current and voltage, and in general the voltages were all below 6V.

(b) Most candidates accurately calculated the resistance and recorded values to 1 decimal place. The Resistance column in the table was generally appropriately headed although, not always with the preferred solidus.

(c) **(i)** The graphs were generally well plotted although a small but significant number of candidates were confused by the scale. The labels were well completed and again the points required a clearer symbol than a simple dot.

(ii) Most candidates added a straight line to the graph.

Higher Tier

Booklet B

Overview

This paper allowed candidates of all abilities to show their knowledge and skills in a comprehensive range of scientific investigatory and experimental concepts. It provided opportunities for more able candidates to demonstrate their mastery of the practical elements of the course. In general, all candidates performed well in a discriminating paper. Candidates showed good data processing skills and responded well to the demands of the paper. Calculations were well displayed. Graphs were well plotted and conclusions justified. Candidates were aware of the need for a quantity and unit on the heading of a table and most completed this correctly. However, some candidates also included units in the body of the table. The paper was familiar in its approach, the language level was appropriate for candidates at GCSE level. There was no indication that candidates were short of time to finish the paper. Candidates demonstrated developed skills and rose to the demand of the questions. In general, this was considered to be a very successful paper.

Q1 **(a)** Many candidates failed to mention the requirement that the scale should be read at the same level or eye level. Many explanations, while valid, did not address this fundamental concept.

(b) **(i)** The column label was well addressed by most candidates with the correct unit. This was not always completed using the more acceptable solidus, but creditworthy at this level. Most candidates correctly calculated the force, given the mass in grammes. However, a significant number of candidates found this challenging and resulted in giving incorrect force values. Again, the requirement for one decimal place was not always adhered to. Some candidates failed to read the question carefully.

(ii) This was the better completed column in the table with an appropriate heading and extensions calculated correctly by most candidates. Again, the decimal places were not always correct.

(c) **(i)** The graph was generally well plotted, often with an error carried forward. Most candidates correctly labelled the axes. Points were accurate to within a small square. Some candidates used a zig-zag line if their axes started at zero but did not increase initially in an even way. Some candidates correctly started their axes at a measure greater than zero which was also correct. However, some candidates lost marks by indicating a zero and then offering an uneven increase in their axes values. Some candidates lost a mark due to transposed axes.

(ii) Most candidates used a value substituted into the equation or correctly found the gradient. The unit proved more challenging to some. An error carried forward was also applied to the benefit of some candidates.

(iii) This was a discriminating task for many. Some candidates drew a parallel line to their original line. Some candidates did not attempt this part of the paper. Some gained partial credit for steeper lines but not exactly double the gradient.

Q2 **(a)** **(i)** This moments question was well answered. Most candidates gained full credit.

(ii) This was a discriminating question with only the better candidates giving a detailed explanation involving mathematical justification.

(b) **(i)** Most candidates correctly identified the centre of gravity. A significant number of candidates marked the pivot as the centre of gravity.

(ii) Many candidates mis-read the instruction and lost the mark for this question.

(iii) This was well answered by the more able candidates and was discriminating. For partial credit, many candidates offered suitable workings to be awarded marks for the principle of moments equation and one side of substitutions. Candidates with poorly displayed incorrect working out, failed to gain credit.

(iv) Most candidates recognised the requirement for repeating and averaging although, often their method was unworkable.

Q3 **(a)** **(i)** Many candidates failed to draw the correct symbol for a variable resistor.

(ii) Only the better candidates explained how to use the components clearly and correctly.

(b) **(i)** Most candidates correctly plotted the graph. Only a small number transposed the axes. The axes were well labelled and the points correctly plotted by most candidates. Most candidates correctly constructed a best fit line although, a very small number did not draw a line.

(ii) This was well answered by most candidates with many substituting the values of a point.

(c) **(i)** Many candidates failed to achieve the full marks for recognising the variables. Many candidates explained the meaning of the dependent variable rather than simply expressing it as the measured one but gained full credit.

(ii) Again, many candidates recognised the correct variable but a significant number were confused. Some stated the independent variable but offered no reasoning.

(iii) This was well answered. Most candidates stated the number of turns or the core as the control. Some candidates did not explain why their choice was the controlled variable.

(iv) This was well answered with many good explanations.

Q4 **(a)** **(i)** Many candidates calculated the time correctly but failed to adhere to the decimal place criteria.

(ii) Most candidates identified the anomalous value.

(iii) Most candidates gave their reasoning for identifying the anomalous result.

(b) **(i)** Some candidates plotted the wrong time values. Some candidates did not fit a line to the points. Most plotted accurate graphs.

(ii) Most determined the gradient but frequently the decimal place criteria was ignored.

(iii) This was a discriminating question, with only the better candidates able to accurately convert the quantity to m/s.

(c) This was also a discriminating question. Only the candidates with better mathematical skills were able to cope with the rearrangement of the substituted equation.

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