PHYSICS

Paper 0972/11
Multiple Choice Core

Question Number	Key
1	B
2	D
3	A
4	C
5	B
6	B
7	B
8	D
9	A
10	B

Question Number	Key
11	C
12	C
13	C
14	B
15	D
16	B
17	A
18	B
19	D
20	C

Question Number	Key
21	D
22	A
23	C
24	B
25	C
26	B
27	A
28	D
29	C
30	C

Question Number	Key
31	D
32	A
33	C
34	C
35	A
36	C
37	D
38	D
39	C
40	A

General comments

There was a wide range of scores on the paper, with some candidates showing a good understanding of the syllabus content. **Questions 1**, **13**, **16**, **29**, **31** and **38** were answered well by the vast majority of candidates. Candidates found **Questions 15**, **21**, **28**, **32**, **33**, **37**, **39** and **40** more challenging.

Comments on specific questions

Question 13

Although most candidates correctly identified the movement of molecules in liquids and solids, there were a few who thought that there was no movement of the molecules in a solid.

Question 15

Most candidates understood that liquid Y, with the larger expansivity, expands more than liquid X, which has the smaller expansivity. However, some candidates did not realise that liquid Y contracts more than liquid X when it is cooled.

Question 16

Only stronger candidates were able to identify the materials from which the pan was made and showed good practical understanding of conduction.

Question 21

Only stronger candidates showed an understanding of total internal refraction. The question clearly stated that the angle of incidence is greater than the critical angle and therefore, all the light is reflected back into the glass.

Question 28

This question proved challenging for many candidates. The circuit is a form of potentiometer, the current is the same in both resistors and therefore (using $V = IR$) the potential difference across the $2.0\,\Omega$ is twice that across the $1.0\,\Omega$ resistor. The total potential difference across the two resistors is the sum of the potential differences across the two resistors which is 18 V.

Question 29

Most candidates recognised that the energy lost is in the form of low-grade thermal energy.

Question 31

The majority of candidates correctly identified the components in the circuit. Those who got it wrong, almost always confused cells with batteries.

Question 32

Many candidates thought that the total resistance of two resistors in parallel is equal to the average of the two resistances rather than it being smaller than either resistor. The logic is that the charge carriers now have a choice of paths to take, meaning that more charge carriers can pass per unit time.

Question 33

Only stronger candidates showed full understanding of the role of the earth wire in a domestic electricity supply.

Question 37

Only stronger candidates demonstrated their understanding of the α-scattering experiment. To show full understanding of the experiment, candidates needed to know that a small proportion of the α-particles are repelled by the nucleus and that the electric charge on the nucleus is produced by the protons in the nucleus.

Question 39

Candidates were expected to be able to identify the types of radiation in an absorption experiment from the results of the experiment. To do this, they needed to show knowledge of penetration of the different types of radiation through different materials. Only stronger candidates showed this basic knowledge.

Question 40

Only stronger candidates answered this correctly. Candidates needed to be familiar with, and to fully understand the meaning of half-life in order to answer this type of question.

PHYSICS

Paper 0972/21
Multiple Choice Extended

Question Number	Key
1	D
2	D
3	A
4	C
5	C
6	B
7	A
8	D
9	B
10	B

Question Number	Key
11	A
12	C
13	B
14	C
15	D
16	B
17	D
18	B
19	B
20	C

Question Number	Key
21	D
22	A
23	C
24	B
25	B
26	B
27	C
28	D
29	B
30	D

Question Number	Key
31	C
32	A
33	C
34	C
35	A
36	D
37	C
38	A
39	B
40	A

General comments

There was a wide range of marks scored on the paper **Questions 1**, **3**, **4**, **11**, **12**, **16**, and **39** were answered well by the vast majority of candidates. Candidates found **Questions 5**, **13**, **22, 31**, **36**, **37**, **38** and **40** very challenging.

Comments on specific questions

Question 4

A question common to Paper 11 and 21 which was answered well showing a good understanding of density.

Question 5

The question required a calculation that many seemed to be unfamiliar with. Candidates needed to understand that the resultant vertical force on the bridge is equal to the total downward force, and then to take moments about one of the pillars. This gives a pair of simultaneous equations which can be used to find the values of T_1 and T_2.

Question 11

This was answered excellently with virtually all candidates recognising that the pressure on the base of the flasks due to a liquid depends only on the depth of the liquid.

Question 12

Another well answered question – candidates seemed to have a good understanding of the process of evaporation.

Question 13

Nearly half the candidates were under the misapprehension that all the gas was pushed into the 20 cm^3 cylinder, rather than the gas now being contained in both cylinders giving an increased volume of 100 cm^3.

Question 29

The general principle is that the larger the current in the resistor the hotter it gets. Not only does the current increase as the voltage increases but it increases at an increasing rate as the voltage increases, indicating that the resistance decreases as the voltage increases and the component gets hotter.

Question 36

This was a very challenging question, the most common response was to choose option **B**, no change. In practice the interaction between the field from the magnetic poles and the current cause an upward force on the wire and a downward force on the magnetic poles themselves. This downward force pushes the top pan balance downwards, leading to an increased reading.

Question 37

Many candidates thought that the neutron number fell by 4. This may have been because candidates did not read the question carefully enough and were confused between neutron number and nucleon number.

Question 38

Many candidates were unclear how to use the information about the background count. The most common mistake was to, correctly, subtract the background count (30) from the initial count (530 – 30 = 500), halve what remains (500 / 2 = 250) but they then failed to add the background count to this before reading the half-life from the graph. Other candidates totally ignored the background count and simply halved the initial count.

Question 39

Most candidates answered this well, with only a few candidates under the impression that the 340 counts were all from the source.

Question 40

Candidates should be aware of the uses of different types of ionising radiation. Even without this specific knowledge, they should be able to deduce which statement is incorrect from the known properties of the different radiations.

PHYSICS

Paper 0972/31
Core Theory

Key messages

- Candidates should ensure they are clear about what a significant figure is. Centres should encourage candidates not to round to 1 significant figure and should set practice exercises on this topic.
- Centres should encourage candidates to ensure that working and answers to numerical questions are as clear as possible and that all handwriting is legible.

General comments

Most candidates were well prepared for this exam and were able to apply their knowledge and physics understanding to the questions set to produce correct responses.

Candidates should ensure their use of language is precise, particularly when using the pronouns "it' or "they" to ensure their answers are clear. Similarly, candidates frequently stated a property had changed but failed to state how it had changed i.e., increased/decreased.

Almost all candidates attempted all the items and there was no evidence of candidates having insufficient time to complete the paper.

Comments on specific questions

Question 1

(a) The majority of candidates gained full credit but errors in using the millimetre scale on the ruler were common. A small number of candidates used their own rulers rather than the ruler in the figure.

(b) (i) The vast majority of candidates correctly identified some form of balance as a suitable device for measuring mass.

(ii) The majority of candidates correctly determined the volume as 4 cm^3 using the scale on the measuring cylinders. A common error was to simply state the volume with the wire submerged, i.e., 22 cm^3.

(c) Most candidates correctly evaluated the density as being 7.8 g/cm^3. The most common error was to use an incorrect arrangement of the equation density = mass/volume.

Question 2

(a) (i) Almost all candidates correctly stated the times indicated on the stopwatches. A common error was to simply write down the numbers shown on the stopwatches, e.g., 0614, instead of placing a decimal point after the 6 to read 6.14 s.

(ii) The majority of candidates correctly determined the average of the two readings. A common error was to subtract the two readings instead of adding them before dividing by two.

(iii) Most candidates correctly stated that decreasing the angle of the slope would decrease the speed of the trolley. The most common error was to make statements that were too vague, e.g., “move the block backwards”.

(b) Almost all candidates correctly determined the average speed as 0.15 m/s. The most common errors were using an incorrect arrangement of the equation, or rounding their answer to one significant figure, i.e., 0.2 m/s.

(c) The majority of candidates correctly determined the distance travelled by evaluating the area under the graph as 3.2 m. The most common error was to state distance = speed x time, and to evaluate 1.6 × 4.0. Weaker candidates divided the time by the speed.

Question 3

(a) Only the strongest candidates gained full credit here. The majority of candidates gave vague descriptions which indicated that they had never seen or attempted a similar experiment. Centres should encourage candidates to carry out the experiments listed in the specification.

(b) The vast majority of candidates correctly calculated the moment of the weight as 28 Ncm. Weaker candidates divided the distance by the weight.

Question 4

(a) Most candidates drew acceptable graphs to show the cooling and freezing of the substance. The most common error was the omission of a horizontal section at 20°C to indicate the freezing of the substance.

(b) Almost all candidates gained credit for this question, indicating that the kinetic molecular model of matter was well understood for solids.

Question 5

(a) Most candidates correctly calculated the pressure of the bottle on the bench as 0.48 N/cm^2. Weaker candidates used an incorrect arrangement of the equation, often multiplying 25 and 12.

(b) Only stronger candidates answered this correctly. Weaker candidates did not link the collisions of high-speed molecules on the walls of the bottle with the internal pressure of the bottle. Very few compared the internal gas pressure and the external atmospheric pressure.

Question 6

(a) (i) (ii) The majority of candidates gained at least partial credit. A common error was to state that Q was the amplitude of the wave, and that T was the wavelength of the wave.

(iii) Many candidates gave correct statements for the frequency of a wave. The most common error was to give a vague reference to time, rather than stating the number of waves sent out in one second.

(b) Most candidates gained at least partial credit for this question and were able to describe an experiment to determine the speed of sound in air.

Question 7

(a) Many candidates found this item challenging, with many drawing a reflected rather than a refracted ray. Only stronger candidates correctly identified the angle of incidence and the angle of refraction.

(b) Only stronger candidates were able to link the angle of incidence being greater than the critical angle causing the ray to have total internal reflection.

(c) (i) Only stronger candidates stated that the speed of light was the same as the speed of the X-rays. Candidates seemed evenly split on whether the frequency of visible light was lower or higher than the frequency of X-rays.

(ii) The vast majority of candidates were able to give a suitable use of X-rays.

Question 8

(a) (i) The vast majority of candidates answered this correctly.

(ii) Stronger candidates gained full credit for this question. Very few candidates linked the induced magnetism in the iron bar to two opposite poles being next to each other and therefore attracting.

(b) (i) The majority of candidates gave good descriptions of the movement of electrons. Weaker candidates did not identify the direction in which the electrons moved, or stated that positive charges were moving.

(ii) The majority of candidates answered this correctly. A common error was to state two insulators.

Question 9

(a) (i) The vast majority of candidates correctly identified a voltmeter. The most common error was to state ammeter.

(ii) The majority of candidates answered this correctly. A common error was to state voltage rather than volt.

(b) (i) The majority of candidates correctly evaluated the resistance as 32 ohms. The most common error was to use an incorrect arrangement of the equation V = IR.

(ii) Only stronger candidates were able to link increased length and smaller diameter to an increase in resistance.

Question 10

(a) (i) Stronger candidates were able to describe the need to both connect the wire to the galvanometer and then to move the wire near the magnet.

(ii) The majority of candidates were able to give two ways of increasing the e.m.f. The most common errors were to state “increase the current” or “use a bigger magnet”.

(b) (i) Many candidates found this item challenging, with very few drawing an arrow from the north pole to the south pole of the magnet.

(ii) The majority of candidates gave two ways of increasing the speed of rotation of the coil.

(iii) The majority of candidates were able to describe a method for reversing the direction of rotation of the coil.

Question 11

(a) The majority of candidates gained at least partial credit. A common error was to indicate that gamma radiation was the most ionising.

(b) The majority of candidates calculated that three half-lives had passed in 45 hours, but only the strongest could then go on to determine that 10 mg would remain after 45 hours.

PHYSICS

Paper 0972/41
Extended Theory

Key messages

- Candidates need to be able to rearrange equations accurately and to calculate answers carefully.
- The correct unit for every syllabus quantity needs to be known and given with almost every numerical answer.
- Answers should be rounded correctly to the specified number of significant figures.
- To be awarded full credit, candidates need to answer the question as it has been asked and need to pay close attention to a command word or any other instruction.

General comments

Many candidates answered well and were able to show their subject knowledge in answers to the questions set.

Comments on specific questions

Question 1

(a) This question was extremely well answered with almost all candidates answering fully and correctly. However, the question asked how a vector quantity differs from a scalar quantity. Some candidates gave an answer such as “it has a direction and a magnitude” which did not make it clear that it is the need for a direction that constitutes the difference.

(b) This was usually answered well. There were candidates who gave two correct vectors but did not underline “momentum”. Some of the other quantities were also underlined by a few candidates.

(c) (i) The correct answer was very frequently given. Errors that occurred included the omission of the unit or the use of an incorrect unit. J and kg were the most common of these incorrect units.

(ii) Only stronger candidates answered this correctly. Other candidates drew either a triangle or a parallelogram but only a minority of these included a right angle and few were drawn to scale.

(iii) This test on the conditions for equilibrium was not well understood and few candidates gained credit here.

Question 2

(a) Most candidates realised that heat capacity is related to the energy needed to increase temperature and in general this was answered well with full credit frequently awarded. However, a common omission was to make no reference to the magnitude of the temperature increase (1°C) and some candidates added an incorrect reference to the mass being 1 kg.

(b) (i) A molecular account was asked for and so answers that did not mention molecules or particles in some way did not answer the question fully. The relationship between the kinetic energy of the molecules and the internal energy was not always supplied and the dependence on the molecular potential energy was even rarer. Some answers suggested that it was the internal energy of the ice that was being discussed.

(ii) This was usually fully correct. However, there were some candidates who confused the energy supplied with the specific heat capacity and who obtained an answer that was equivalent to the incorrect expression c / mDT.

(c) (i) Answers needed to refer to energy and the fact that energy is absorbed by the ice as it melts. Many candidates referred to the intermolecular bonds being broken or overcome as the ice became water but not all included a comment on the energy needed to do so.

(ii) There were many references to measuring the temperature as the ice melted and even to timing how long it would take to melt completely. Statements about the change in mass were rarer. Many candidates described the calculation that would need to be carried out or simply wrote down an equation for specific latent heat of fusion.

Question 3

(a) The molecular explanation for the pressure exerted by a gas trapped in an inflated balloon was required here and needed to be in terms of the momentum of the molecules. Only stronger candidates included any comment concerning momentum.

(b) (i) This question was usually correctly answered but some candidates who used the correct approach calculated an answer that was either too large or too small by a factor of ten. This error often occurred when candidates were trying to give an answer in m^3. Answers given in cm^3 were acceptable. Some candidates assumed that the volume of the air was directly proportional to the pressure and obtained a volume greater than that given in the question.

(ii) Many candidates made one or two useful points in their explanations but only a minority were awarded full credit. Very few candidates commented on the outside pressure of the water causing the volume of the air in the balloon to decrease.

Question 4

(a) Although few candidates gave a suitable straight line for **(i)**, correct curves for **(ii)** were much more frequently seen and **(ii)** was in general answered well.

(b) This calculation was usually performed accurately, and the correct final answer was common. Errors included omitting to square the speed even when the term v^2 had been included when the equation or correct expression had been given by the candidate earlier. A minority of candidates calculated the momentum of the train.

(c) (i) This question was only answered correctly by stronger candidates. Many candidates wrote vague comments about energy or force but did not give the exact definition that was required. Some candidates who did realise that an equation or defining expression was required, did not refer to the distance moved being in the direction of the force and just gave force × distance as the answer.

(ii) This was correctly answered by many candidates. Candidates who gave answers that were greater than 600 m (the largest value on the *y*-axis of **Fig. 4.1**) had probably misunderstood the question.

(iii) The easiest route to the correct answer was to use the definition of work done and to divide the kinetic energy by the distance travelled. Very few candidates did this and more obtained a value for the deceleration which was then multiplied by the mass of the train. Credit was commonly awarded for the expression F = ma.

Question 5

(a) Few candidates were able to accurately explain what was meant by "principal focus". Some answers were very vague and some of the clearer ones defined the position of an image produced by the lens.

(b) Most candidates gave an answer that included a distance. However, some answers suggested that the distance between the principal focus and the focal point or the distance between the focal point and the principal axis was the distance required.

(c) (i) Many candidates drew the ray mentioned in the question but not all of these then drew line L in the correct position.

(ii) Many candidates drew either the correct ray or the ray that related in the same way to their diagram. This often led to a distance for the focal length that was awarded credit.

(iii) Most candidates ticked either the third or fourth diagram. The fourth diagram was correct and those who ticked the third diagram had perhaps only considered the vertical inversion or had not realised that the translucent screen was being observed from P (as shown on **Fig. 5.1**).

Question 6

(a) (i) There were many answers here that gained full credit. Occasionally, the only error was reversing the terms "infrared" and "ultraviolet". Some candidates included other types of electromagnetic radiation, sound or ultrasound or even alpha-particles, beta-particles or gamma rays.

(ii) The answer given here was usually correct either in absolute terms or as an error carried forward from the previous part.

(b) This question was often answered well, and full credit was awarded. There were answers that were approached in a completely correct fashion until the calculation was conducted. Many candidates had difficulty with divisions that included numbers in standard form. The numerical part of answers that could be expressed as 2.5×10^{N}, (where N is not 17) were not uncommon. A second source of inaccuracy arose from misremembering the magnitude of the speed of electromagnetic radiation. Values such as 330 m / s, 3.0×10^{6} m / s and 3.8×10^{8} m / s were unusual.

(c) (i) Almost all candidates chose to describe the use of X-rays in the diagnosis of broken bones and most candidates were awarded some credit.

(ii) Many candidates were able to supply one reason for the need of safety precautions, but a few candidates gave answers that were not sufficiently precise. Stating that X-rays are dangerous was not sufficient here.

Question 7

(a) Many candidates mentioned electrons and stated that they were being transferred in the correct direction from the cloth to the rod.

(b) (i) Few candidates described how the conducting ball became positively charged, and more stated that it was positive and that the attraction of opposite charges led to its jumping up towards the negative rod. The comment that the ball contained positive charges was not the same as stating that it was positively charged.

(ii) There were some good answers here but some answers were given in terms of the motion of positive charges or of protons. This was sometimes instead of the motion of electrons and sometimes in addition to it. Some candidates became confused by what was happening to the rod which in a few descriptions had previously been positive and was becoming negative because of contact with the positive ball.

Question 8

(a) Many candidates answered this question correctly but there were also many answers that did not gain any credit. Some candidates gave answers in terms of potential difference and resistance. This did not reveal what is meant by the term "current".

(b) Only stronger candidates supplied an answer in terms of I_1 and I_2 as required.

(c) Many candidates realised that a current could be calculated from the equation $I = V / R$ and then a power from $P = VI$. Fewer candidates applied these equations correctly in the circuit. Most candidates gained partial credit for this question.

(d) Only stronger candidates answered this correctly. Other candidates started off poorly by stating that the increase in the intensity of the light would result in an increase in the resistance of the (light-dependent resistor) LDR. Even those that gave the correct effect of the brighter light struggled to deduce and explain how this would affect the potential difference (p.d.) across the 450 W resistor.

Question 9

(a) Although the composition of the neutral atom was often described accurately, very few candidates describe the structure. Answers that merely stated the number of protons, neutrons and electrons were only awarded partial credit.

(b) The question asked for the difference between the two atoms to be described but many descriptions were too vague for credit.

(c) The presubscript (38) was often correctly stated but the presuperscript was less often correct. Many candidates did not take the effect of the initial incident neutron into consideration, but other arithmetic errors were also made.

(d) Many candidates realised that during beta-decay, the nucleon number of a nuclide does not change and **(ii)** was answered well by many candidates. The effect on the proton number was more challenging and although stronger candidates answered well, a common incorrect answer was 53.

PHYSICS

Paper 0972/51
Practical Test

Key messages

- Candidates need to have a thorough grounding in practical work during the course, including reflection and discussion on the precautions taken to improve reliability and control of variables.
- Candidates should be aware that, as this paper tests an understanding of experimental work, explanations and justifications need to be based on practical rather than theoretical considerations.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit where applicable. Candidates should know that these techniques will be tested at some point in the paper.
- Candidates should be ready to apply their practical knowledge to different situations.
- Questions should be read carefully to ensure that they are answered appropriately.

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques, including the following:

- plotting graphs
- tabulating readings
- manipulating data to obtain results
- drawing conclusions
- dealing with possible sources of error
- controlling variables
- handling practical apparatus and making accurate measurements
- choosing the most suitable apparatus.

It is assumed that, as far as possible, the IGCSE course will be taught so that candidates undertake regular practical work as an integral part of their study of physics.

Questions on experimental techniques were answered much more effectively by candidates who showed evidence of undertaking similar practical work. Some candidates appear to have learned sections from the mark schemes of past papers and gave written responses that were not appropriate to the questions set.

The practical nature of the examination should be kept in mind when explanations, justifications or suggested changes are required, for example in **Questions 2(d)**, **3(f)** and **3(g)**.

Comments on specific questions

Question 1

(a) The majority of candidates successfully recorded the top and bottom scale readings in mm. Some appeared to have taken the measurement from **Fig. 1.1** instead of from their apparatus. Most candidates successfully calculated the length of the spring.

(b) Some candidates calculated the increase in extension for each load rather than the total extension. Most produced realistic readings for the increasing length of the spring.

(c) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates chose a scale that resulted in the plots occupying too small a proportion of the graph grid. Plotting was generally accurate, but a significant number of candidates did not include the plot at the origin. Candidates should use neat crosses for the plots, or neatly circled dots so that the accuracy of the plotting is clear. Many candidates drew a well-judged straight line, but some drew a dot-to-dot line and others drew a straight line that did not match the plots.

(d) Here candidates needed to show clearly the distances. Some candidates drew very careful lines that showed exactly what was required. Most candidates successfully showed the original and stretched lengths but some then gave a confusing indication of the extension.

Question 2

(a) Most candidates recorded realistic values for current and potential difference and calculated the resistance correctly.

(b) Candidates who had rearranged the circuit correctly obtained a value for V_{XY} greater than V_X. Correct use of the units A, V and Ω was credited here.

(c) (i) The diagram required two resistors in parallel and a complete circuit with correctly positioned ammeter and voltmeter with all the correct circuit symbols used and the third resistor in series.

(ii),(iii) Candidates were credited for completing the third set of readings with V_{XZ} less than V_X and then obtaining the value of R_{XZ} within $\pm$ 10 per cent of $R_X / 2$. Candidates who had carefully followed the instructions and rearranged the circuit correctly each time produced a result within tolerance.

(d) Candidates gained credit for suggesting the use of at least four additional resistors. Values between 1 Ω and 20 Ω were expected with a range such that the largest value was at least twice the smallest value. Many candidates gave responses that were too vague and some produced a theoretical explanation of the combined resistances of resistors in parallel and series that did not address the question.

Question 3

(a) Most candidates drew the normal and incident rays accurately.

(b) Many candidates drew neat and accurate lines. Fewer candidates placed the pins P_1 and P_2 correctly at a distance of at least 5 cm apart.

(c) Most candidates measured the angle α accurately.

(d) A significant number of candidates drew the second reflected ray in a position that indicated that they had not moved the mirror to the new position specified in the instructions.

(e) Most candidates included the unit ° for the angles and carefully followed the instructions with accurate line drawing, producing angles within the accepted tolerance.

(f) Candidates were expected to suggest at least three additional angles of incidence with a range of at least 30° and all less than 90°.

(g) Some vague responses were seen here and some that appeared to have been learned from past mark schemes that were not appropriate for this question. This included references to doing the experiment in a darkened room. Stronger responses mentioned difficulty in lining up the pins and the thickness of the mirror.

Question 4

Candidates who followed the guidance in the question were able to write concisely and addressed all the necessary points. Some candidates copied the list of apparatus and other information given in the question. This was unnecessary and often introduced a vague explanation of the investigation.

Candidates needed to include a stopwatch (or other timing device) to gain initial credit.

A concise explanation of the method was required. Candidates should have concentrated on the readings that must be taken and the essentials of the investigation. It may benefit candidates to plan their table of readings before writing the method to help them to think through the measurements that must be taken to address the subject of the investigation. Candidates were expected to explain that water is to be heated in a container to a specific temperature. Some chose boiling point which was acceptable, and others chose a suitable fixed temperature, for example 80°C. Candidates then needed to make it clear that the procedure is repeated with at least two additional containers. A vague reference to repeats was not sufficient as it was not clear whether the candidate was referring to using different containers or repeating the measurements with the same container.

Candidates were expected to identify that the volume of water should be kept constant. Also, they were expected to note that starting temperature should be constant.

Many candidates drew a suitable table. They were expected to include columns for type of container and time with the unit s.

Candidates were expected to explain how to reach a conclusion by comparing the times for the various containers. The question did not ask for a prediction. Some candidates wrote a prediction but no explanation of how to reach a conclusion.

PHYSICS

Paper 0972/61
Alternative to Practical

Key messages

- Candidates need to have a thorough grounding in practical work during the course, including reflection and discussion on the precautions taken to improve reliability and control of variables.
- Candidates should be aware that as this paper tests an understanding of experimental work, explanations and justifications need to be based on practical rather than theoretical considerations.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit where applicable. Candidates should know that these techniques will be tested at some point in the paper.
- Candidates should be ready to apply their practical knowledge to different situations and should read questions carefully to ensure that they are answered appropriately.

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques, including the following:
- plotting graphs
- tabulating readings
- manipulating data to obtain results
- drawing conclusions
- dealing with possible sources of error
- controlling variables
- handling practical apparatus and making accurate measurements
- choosing the most suitable apparatus.

It is assumed that, as far as possible, the IGCSE course will be taught so that candidates undertake regular practical work as an integral part of their study of physics.

Questions on experimental techniques were answered much more effectively by candidates who showed evidence of having regular experience of similar practical work. Some candidates appeared to have learned sections from the mark schemes of past papers and written responses that were not appropriate to the questions in this paper.

The practical nature of the examination should be considered when explanations, justifications or suggested changes are required, for example in **Questions 2(e)**, **3(e)**, **3(f)** and **3(g)**.

Comments on specific questions

Question 1

(a) The majority of candidates successfully recorded 439 mm and 454 mm, but some gave the readings in cm. Some appeared to have taken the measurement from **Fig. 1.1** instead of from the information in the question. Most candidates calculated the difference correctly

(b) Most candidates calculated *e* correctly. Some candidates left the column heading blank but most of those who completed it correctly inserted mm.

(c) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates chose a scale that resulted in the plots occupying too small a proportion of the graph grid. Plotting was generally accurate but a significant number of candidates did not include the plot at the origin. Candidates should use neat crosses for the plots, or neatly circled dots so that the accuracy of the plotting is clear. Many candidates drew a well-judged straight line but some incorrectly drew a dot-to-dot line whilst others drew a straight line that did not match the plots.

(d) Here candidates needed to show the distances clearly. Some candidates drew very careful lines that showed exactly what was required. Most successfully showed the original and stretched lengths but some then gave a confusing indication of the extension.

Question 2

(a) Most candidates recorded correct values for current and potential difference and calculated the resistance successfully. The units A, V and Ω were required and most candidates included these correctly.

(b) Candidates were expected to realise that the values were too different to be accepted as equal within the limits of experimental inaccuracy.

(c) The diagram required candidates to draw two resistors in parallel and to have a complete circuit with a correctly positioned ammeter and voltmeter with all the correct circuit symbols used and the third resistor in series.

(d) Many candidates wrote the resistance correctly to two significant figures but some gave it to two decimal places.

(e) Candidates gained credit for suggesting the use of at least four additional resistors. Values between 1 Ω and 20 Ω were expected with a range such that the largest value was at least twice the smallest value. Many candidates gave responses that were too vague and some produced a theoretical explanation of the combined resistances of resistors in parallel and series that did not address the question.

Question 3

(a) Most candidates drew the normal correctly and the lines with the correct length. Fewer drew the lines at the correct angles.

(b) Many candidates showed pin positions that were too close to each other. Candidates were expected to indicate positions at least 5 cm apart. Candidates who intended to show the pins exactly 5.0 cm apart risked the distance being just too short.

(c) Candidates were expected to have drawn the correct line and to measure the angle at 70° to within $\pm$ 2°.

(d) Most candidates successfully included the unit ° for the angles.

(e) Candidates were expected to suggest at least three additional angles of incidence with a range of at least 30° and all less than 90°.

(f) Some vague responses were seen here and some that appeared to have been learned from past mark schemes that were not appropriate for this question, for example references to doing the experiment in a darkened room. Stronger responses included difficulty in lining up the pins and the thickness of the mirror.

(g) Candidates were expected to tick boxes 2, 3 and 5.

Question 4

Candidates who followed the guidance in the question were able to write concisely and addressed all the necessary points. Some candidates copied the list of apparatus and other information given in the question. This was unnecessary and often introduced a vague explanation of the investigation.

Candidates needed to include a stopwatch (or other timing device) in order to gain initial credit.

A concise explanation of the method was required. Candidates needed to concentrate on the readings that were required and the essentials of the investigation. It may have benefited candidates to plan their table of readings before writing the method to help them to think through the measurements that needed to be taken to address the subject of the investigation. Candidates were expected to explain that water was to be heated in a container to a specific temperature. Some chose boiling point which was acceptable, and others chose a suitable fixed temperature, for example 80°C. Candidates then needed to make it clear that the procedure was repeated with at least two additional containers. A vague reference to repeats was not sufficient as it was not clear whether the candidate was referring to using different containers or repeating the measurements with the same container.

Candidates were expected to identify that the volume of water should be kept constant. Also, they were expected to note that starting temperature should be constant.

Many candidates drew a suitable table. They were expected to include columns for type of container and time with the unit s.

Candidates were expected to explain how to reach a conclusion by comparing the times for the various containers. The question did not ask for a prediction. Some candidates wrote a prediction but no explanation of how to reach a conclusion.