PHYSICS

Paper 0972/11
Multiple Choice Core

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**C**
2	**C**	22	**C**
3	**B**	23	**C**
4	**C**	24	**C**
5	**D**	25	**D**
6	**D**	26	**B**
7	**C**	27	**A**
8	**C**	28	**A**
9	**C**	29	**C**
10	**B**	30	**C**
11	**A**	31	**D**
12	**C**	32	**D**
13	**C**	33	**A**
14	**B**	34	**B**
15	**C**	35	**C**
16	**C**	36	**B**
17	**C**	37	**A**
18	**A**	38	**D**
19	**D**	39	**D**
20	**A**	40	**A**

General comments

Many candidates answered the questions well. Although there were areas of the syllabus which caused major problems, such as electromagnetism and radioactivity, there was evidence that many candidates had a good understanding of the majority of the syllabus. **Questions 1**, **4**, **5**, **8**, **11**, **20**, **26** and **37** were answered well, whereas **Questions 17**, **19**, **28**, **35**, **39** and **40** proved more challenging.

Comments on specific questions

Question 2

The question was reasonably well answered but a significant number of candidates multiplied the maximum speed by the time taken, rather than using the average speed.

Question 4

Most candidates were able to identify weight as a gravitational force.

Question 5

Candidates showed a good understanding of calculating density, and the majority coped well with the challenging arithmetic.

Question 8

Most candidates recognised that increasing the mass of the base of an object increases its stability.

Question 11

The vast majority of candidates were able to extract the relevant information from the graph.

Question 17

Only stronger candidates realised that a liquid-in-glass thermometer uses the change in volume of the liquid in order to measure temperature. Many candidates thought it was a change in thermal capacity.

Question 19

Only stronger candidates recognised that if the water at the bottom of the container remained cool, then neither the water nor the material, from which the container is made, can be a good conductor.

Question 20

Candidates showed a good understanding that white surfaces reflect radiant energy.

Question 23

Although many candidates got the correct answer here, more candidates read the clock without recognising that the image in a plane mirror is reversed.

Question 25

Although many candidates recognised that the wavelength of the radiations increases going from γ-radiation towards radio waves, a significant number thought it was the frequency that increased.

Question 26

This calculation was done very well indeed.

Question 28

This question was challenging for many candidates. To succeed, candidates needed to recognise that the two magnets in the coil would be magnetised in the same sense. Thus, adjacent poles of the two magnets would be of opposite polarity and they would attract each other regardless of the current direction.

Question 31

Few candidates were able to trace a circuit and recognise circuits which are, in practise, identical.

Question 33

Many candidates answered this question well.

Question 35

A relatively small number of candidates were able to identify the correct answer. A large majority had little idea, most thinking that the maximum e.m.f. is induced when the soft iron rod is moved slowly into the coil. It is likely that they did not understand that any movement of a magnet (in or out) induces an e.m.f.

Question 39

This question was challenging for many candidates. To successfully tackle the question candidates needed to recognise the structure of an α-particle (2 protons and 2 neutrons) and to understand that all isotopes of the same element have the same number of protons and different numbers of neutrons.

Question 40

Candidates did not understand that lead absorbs the radiation from a radioactive source. Most candidates were under the misapprehension that it repels the radiation.

PHYSICS

Paper 0972/21
Multiple Choice Extended

Question Number	Key	Question Number	Key
1	**C**	21	**A**
2	**C**	22	**C**
3	**B**	23	**A**
4	**C**	24	**D**
5	**D**	25	**D**
6	**B**	26	**D**
7	**D**	27	**C**
8	**C**	28	**D**
9	**B**	29	**B**
10	**C**	30	**D**
11	**D**	31	**A**
12	**C**	32	**B**
13	**C**	33	**B**
14	**B**	34	**C**
15	**C**	35	**B**
16	**D**	36	**C**
17	**A**	37	**A**
18	**A**	38	**A**
19	**C**	39	**B**
20	**B**	40	**A**

General comments

The vast majority of candidates were able to answer the questions well. Some questions showed candidates had an excellent knowledge and understanding of the syllabus and there were very few questions which caused major problems. **Questions 1**, **4**, **5**, **15**, **27**, **29**, **30** and **37** were answered well whereas, **Questions 2**, **17**, **28**, **36**, and **39** proved more challenging.

Comments on specific questions

Question 2

This question was challenging for many candidates who thought that the acceleration increased as the object fell. This was probably because they considered the increase in the gravitational field strength as the object got closer to the Earth, without considering the much larger effect of air resistance increasing as the speed of the object increased.

Question 5

The majority of candidates recognised it is the centripetal force which keeps an object moving in a circular path at constant speed, but some candidates were under the misapprehension that a force in the direction of motion is needed to allow an object to maintain a constant speed.

Question 9

Most candidates were able to work successfully through this problem, but there were a significant number of candidates who did not recognise that if the momentum of object X is $+5.0\,m$, the momentum of object Y would be $-3.0\,m$ (where m is the mass of the objects).

Question 11

A common error here was to not recognise that the force against which work is being done is equal to the mass of the bricks multiplied by the Earth's gravitational field.

Question 15

The majority of candidates showed an understanding of the microscopic view of evaporation.

Question 17

This question was challenging for most candidates. The most common response was to incorrectly think that a smaller reservoir would make the thermometer more sensitive. However, this would have the opposite effect. It might mean that the thermometer reacts more quickly to changes in temperature but it would make it less sensitive.

A significant number of candidates thought that increasing the length of the thermometer would make it more sensitive, but in practise it will have no effect unless other changes are made (e.g. narrowing the capillary tube / increasing the volume of the reservoir).

Question 21

The most common error on this question was to think that shorter wavelength waves diffract more than longer wavelength waves.

Question 27

The vast majority of candidates recognised that the positive charge on a rod is due to the loss of electrons.

Question 34

A relatively small number of candidates were able to identify the correct answer and most candidates thought that the maximum e.m.f. is induced when the soft iron rod is moved slowly into the coil. It is likely that they did not understand that any movement of a magnet (in or out) induces an e.m.f.

Question 36

Only stronger candidates answered this question correctly. Candidates needed to recognise that a d.c. motor uses a split ring commutator in order to produce continuous rotation of the coil. This should eliminate options A and B as they suggest slip rings allow the continuous rotation. It then becomes a choice between C and D, and this can be established using the left hand rule.

Question 39

The majority of candidates incorrectly thought that the β-particles are deflected towards one or other of the two magnetic poles. At this level candidates should understand this is an example of the motor effect and that the deflection is at right angles to both the magnetic field and the velocity of the particles.

PHYSICS

Paper 0972/31
Core Theory

Key messages

- In calculations, candidates must set out and explain their working correctly. Partial credit for any correct working may be awarded even if the incorrect final answer it given.
- Candidates should show greater clarity and precision when answering questions requiring a description or explanation.
- It is important that candidates read the questions carefully in order to understand exactly what is being asked.
- In order to improve their performance candidates should practise applying their knowledge to new situations by attempting questions in support materials or exam papers from previous sessions.

General comments

A very high proportion of candidates were well prepared for this paper. Equations were generally well known by stronger candidates but a significant number of other candidates struggled to recall the equations.

Often candidates knew how to apply their knowledge and understanding to fairly standard situations. On occasions, when asked to apply their knowledge to a new situation, they showed a lack of breadth of understanding. More successful candidates were able to think through the possibilities and apply their knowledge when the question asked for suggestions to explain new situations. Weaker candidates did not show the stages in their working and did not think through their answers before writing.

The questions on total internal reading and using stop watches, relating pressure to force and area, renewable and non-renewable energy sources, refraction of light and water waves, drawing ray diagrams and electromagnetic induction were generally more challenging for many candidates. There were a significant number of candidates who either did not read the questions carefully, or gave answers that were related to the topic being tested, but did not answer the question as it had been set.

The English language ability of the majority of the candidates was adequate for the demands of this paper. However, there were a significant number of candidates who struggled to express themselves adequately.

Comments on specific questions

Question 1

(a) This item was challenging for many candidates, with a significant number using an incorrect form of $\rho = m/V$. This was often compounded by a lack of working meaning that candidates failed to gain credit for the correct equation. Candidates should be encouraged to write down a correct form of the equation and then show its re-arrangement.

(b) The majority of candidates gained partial credit, often as a result of only identifying the plastic as being less dense than seawater.

Question 2

(a) The majority of candidates answered correctly. The most common error was to choose diagram P.

(b) Only the strongest candidates gained full credit on this item. Many candidates failed to correctly convert the stopwatch display to a time in seconds. Those who correctly used a time of 83.37s sometimes failed to convert their final answer to 3 significant figures.

(c) The vast majority of candidates answered this correctly. The most common error was to divide by 10 rather than multiplying.

Question 3

(a) The majority of candidates gave clear and precise descriptions of how to determine the extension of the spring. Weaker candidates often gave vague descriptions or gave descriptions involving the spring constant that could not be credited.

(b) (i) The vast majority of candidates answered this question correctly. The most common error was in misreading the load or extension scale or not using a ruler.

(ii) Most candidates gained credit for this question. The most common error was in misreading the load or extension scale or not using a ruler.

(c) Only stronger candidates answered this correctly, with a significant number of candidates using an incorrect form of $W = mg$. This was often compounded by a lack of working meaning that candidates could not be awarded credit for the correct equation.

Question 4

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

(ii) The majority of candidates gained some credit for this question. A common error was to give the unit as N / m. Many other candidates thought that the moment was calculated by dividing the force by the distance from the pivot.

(b) This question proved challenging for many candidates who gave one or two of the key ideas from: (wide tyres have) greater area (in contact with ground), pressure = force ÷ area and so the bigger the area the smaller the pressure. This means the tractor is less likely to sink in soft ground.

Question 5

Many candidates gained full credit for this question. The most common errors were to state that building hydroelectric power stations has no impact on the environment and that wind turbines are turned using gravitational potential energy.

Question 6

(a) (i) Only the strongest candidates gained credit for this question. The most common error was either drawing an incorrect normal or not drawing a normal.

(ii) Many candidates answered correctly. The most common error was poor precision in estimating the angle of reflection at one or both mirrors.

(iii) Very few candidates were able to state the law of reflection. The most common error was to attempt some form of Snell's law.

(b) Very few candidates were able to draw the three rays correctly. Candidates should be encouraged to use a ruler in all ray diagrams and to practise drawing refraction and total internal reflection of light at different surfaces.

Question 7

(a) (i) Very few candidates were able to draw a ray with sufficient accuracy to gain credit. Centres should encourage candidates to use a ruler in all ray diagrams and to practise drawing ray diagrams to show the formation of an image by a thin converging lens.

(ii) Very few candidates were able to draw an image with sufficient accuracy to gain credit.

(iii) Very few candidates were able to correctly identify the position of a principal focus.

(iv) Very few candidates were able to correctly measure the focal length of the lens.

(b) With error carried forward from the diagram, the majority of candidates gained at least partial credit for this question.

Question 8

(a) (i) The vast majority of candidates gained credit for this question.

(ii) Most candidates answered this correctly. The most common error was to state that a sound wave is a transverse wave

(iii) The majority of candidates gained at least partial credit for this question. Responses that were vague or lacked precision were the main source of error.

(b) (i) Most candidates answered this correctly.

(ii) Very few candidates were able to correctly measure the wavelength. The most common error was to give the total length of the waves in the figure 8.2.

(c) Only stronger candidates answered this correctly. The use of water waves to demonstrate refraction was not well understood by many candidates.

Question 9

(a) The vast majority gave the correct patterns, and a majority had the correct direction of the field.

(b) Most candidates were able to describe the movement of electrons and to correctly describe the electrons moving from the plastic rod onto the cloth. Those candidates who did not answer correctly often attempted to describe the movement of positive electrons or even protons.

(c) The majority of candidates gained full credit. Weaker candidates thought that the magnet would attract the copper bar.

Question 10

(a) (i) Most candidates gave the correct symbols, but considerably fewer had them correctly connected.

(ii) The majority of candidates correctly calculated the resistance of the lamp as 18 ohms. Weaker candidates used an incorrect transformation of $V = IR$.

(b) (i) Most candidates clearly identified the variable resistor. The most common error was to state that component X was a resistor.

(ii) Only the strongest candidates were able to link the use of a variable resistor to a change in the circuit resistance giving an ability to control the current in the circuit.

Question 11

(a) Only the strongest candidates gained full credit, and their answers were often very clear and included precise descriptions, assisted by good diagrams. Most candidates did not show secure knowledge about how to demonstrate electromagnetic induction. The most common answer consisted of a description of how to magnetise a piece of iron.

(b) (i) Most candidates were able to state iron as the material used in the core of a transformer. The most common error was to give steel.

(ii) The majority of candidates correctly identified the increased number of turns on the secondary coil compared to the primary coil.

(iii) Many candidates set out a correct transformer equation and substituted values. Candidates who attempted to use some form of ratios often failed to gain any credit.

Question 12

(a) Many candidates gained credit for identifying 2.5 minutes as the half-life. However, the majority of candidates thought that half way down the column of times, i.e. 3 minutes, was the half-life.

(b) Many candidates gained credit for identifying a count rate higher than the starting count rate of the first sample.

(c) (i) Only the strongest candidates answered correctly, usually by using the nuclide notation for a helium nucleus.

(ii) Many candidates gained credit for identifying alpha as being strongly ionising.

(iii) Many candidates gained credit for identifying alpha as being weakly penetrating. However, many incorrectly stated that alpha particles would penetrate paper.

PHYSICS

Paper 0972/41
Extended Theory

Key messages

- All but the very strongest candidates would benefit from more practice in applying their knowledge in unfamiliar situations. This would deepen candidates' understanding and improve their performance in the examination. Many candidates, when asked to apply their knowledge to a new situation, were unable to use the knowledge they had.

- The syllabus symbol for thermal energy has not been *Q* for many years and candidates should be reminded not to use it as such.

- Candidates should ensure that they give their answers clearly in the space provided.

General comments

A high proportion of candidates had clearly been well taught and were prepared for this paper. However on occasion, candidates did not provide the units as required by certain questions. Candidates are expected to know the correct unit for all the quantities mentioned in the syllabus and to supply the appropriate unit as a part of the answer. Sometimes a part question gives information with a unit that included a prefix (e.g. cm or mA) or one of the few non-SI units in the syllabus (e.g. minute). When this happens, the correct answer has to take this into account.

Comments on specific questions

Question 1

(a) This part was very well answered with most candidates supplying the correct answer for both the acceleration and the resultant force. The unit for acceleration was sometimes mistakenly given as m / s^{-2}.

(b) This was generally answered well but some candidates confused the decreasing rate of acceleration with deceleration. There were candidates who, having stated that the rate of acceleration was decreasing, went on to explain that this meant that the speed was decreasing. Expressions such as "the acceleration is slowing down" were not precise enough. Stronger candidates referred to the decreasing gradient of the curve. References to its bending or flattening out were usually too imprecise.

(c) The majority of candidates made some reference to air resistance or a resistive force, but only stronger candidates commented on its increasing in size. There were also some vague answers which gained no credit relating to the car reaching its maximum speed or to the power of the engine being unable to make the car travel faster.

Question 2

(a) Most candidates gave two appropriate properties. A common incorrect answer which was not exact enough to be awarded credit was motion.

(b) (i) There were many good answers that were awarded some credit. A common confusion related to the onset of permanent deformation and in some cases the term *elastic limit* was used. The elastic limit where the deformation becomes permanent is not a syllabus learning objective. It should not be confused with the limit of proportionality which is where Hooke's ceases to apply.

(ii)1 Only stronger candidates answered correctly. There were a vast range of calculated and quoted values given.

(ii)2 Many candidates either quoted the correct equation or used appropriate numbers to show that the equation was known. However, a few candidates obtained the correct answer or gave an answer that was awarded full credit because an incorrect value from **(b)(ii)1** was used correctly.

(iii) There were many correct answers here but, in some cases, an incorrect intermediate energy was given. Thermal energy was not an intermediate stage.

Question 3

(a) Although there were many correct answers here, many candidates gave a correct answer but then continued and contradicted the answer already given trying to explain what the answer meant. One example that occurred often was to give the expression $F\Delta t$ to suggest that this is the force acting at a certain time or the force even per unit time. Sometimes, the answer "rate of change of momentum" was given.

(b) (i) The calculation was frequently carried out correctly and full credit was often awarded. There were candidates who supplied the reciprocal of the correct answer or who multiplied the impulse by the mass of the pellet.

(ii) There were a few candidates who did not know how to address this question, but the majority of candidates did. Of these, there were candidates who having written the term v^2 in the equation, omitted the square when substituting numerical values or even if it was written at this stage, omitted to square the speed when calculating the answer. However, many candidates were awarded full credit.

(c) There were many good answers here with varying points about how the molecular structure of a liquid differs from that of a solid being made. Answers that concentrated exclusively on the bulk properties of solids and liquids were not awarded credit.

Question 4

(a) This part proved challenging for many candidates and few obtained full credit. Many candidates gave answers in terms of the loudspeaker receiving sound and did not refer to the loudspeakers being a vibrating source.

(b) This was very well answered. Many candidates obtained full credit. A minority of candidates did not rearrange the equation $v = f\lambda$ correctly and a few gave an answer which was either too large or too small by factors of ten.

(c) Most candidates had a clear idea of what was expected here and full credit was not uncommon. Most candidates drew straight, incident wavefronts and realised that diffraction would take place to the right of the gap. The most common reasons for not obtaining full credit were diagrams where the wavelength varied significantly or where the wavelength was not even approximately consistent with the value given in the question.

Question 5

(a) There were many good answers here and most candidates drew radial field lines. These were not always evenly spaced and occasionally the arrows were not in the correct direction. A small number of candidates drew the lines inside the sphere or drew lines with a significant curvature.

(b) (i) This was well answered with many candidates drawing an equal number of correctly separated opposite charges. Candidates who drew a large number of charges rarely ensured that the numbers of the opposite charges were equal. Those who only draw a few were much more likely to obtain full credit. A minority of candidates drew only positive charges and were perhaps recalling the end point of a classroom experiment.

(ii) Only stronger candidates answered the question well. Many candidates referred to the charges on S and described what had just been drawn in **(i)**. The question asked for what happens to S.

(iii) There were many good answers with a large number of candidates stating that S ends up being positively charged. Fewer candidates described what happens in the wire or some did not describe the direction of the motion of the electrons in the wire.

(c) There were many good answers here and full credit was commonly awarded. This question asked about the structure of the two substances and so candidates who stated that one was a conductor whilst the other was not, did not answer the question.

Question 6

(a) (i) This was almost always answered correctly, and the small minority of answers not awarded full credit included those where the unit was omitted or incorrect or those where only the equation $V = IR$ was used.

(ii) This question was less well answered. Candidates did not always realise that the fuse rating had to exceed the current supplied and answers that were smaller or equal to the answer in **(ii)** were sometimes seen. Sometimes the unit was omitted here or an answer such as 230 V or 9000 W was given.

(b) This question was generally well answered and full credit was awarded frequently. Candidates who did not obtain full credit often obtained partial credit for quoting an equation that defined specific heat capacity but did not then substitute a correct value for the thermal energy. Some used the value 4200 instead.

(c) (i) Many candidates had some idea of the structure of a thermocouple thermometer but many candidates did not state that the wires are made from two different metals or included a meter that was not described or named. Diagrams where the meter had four terminals and where the wires emerging from the two terminals on one side ended in a junction were sometimes seen. Such diagrams and the accompanying descriptions only occasionally gained partial credit.

(ii) The most common suggestion here was that thermocouples are able to measure a wide range of temperatures or very high temperatures. This was not especially relevant to a bathroom shower and could not be credited. Stronger candidates noted the context and were able to answer appropriately.

Question 7

(a) Almost all answers included a straight line of positive gradient beginning at the origin but fewer answers included appropriate numbers on the axes. Many answers did not include any numbers and in some cases, the 1.0 m mark and the 7.6 W mark defined a point that was clearly not on the drawn line.

(b) (i) This part was often answered in terms of force rather than energy and only a minority of candidates were awarded any credit.

(ii) 1 This part was almost always answered correctly.

2 There were some correct answers but there were also many incorrect answers and a common inaccurate answer was 12 V.

3 Many candidates answered this question correctly, but a common error was to use the value 5.5 (minutes) without converting it to seconds. Answers that were derived from the expression VIt did not gain any credit.

Question 8

(a) (i) There were many good answers here with full credit being awarded quite often. Answers which included a unit (e.g. °) were not awarded full credit because refractive index does not have a unit.

(ii) This was usually correct but a red ray that refracted so that it travelled up the page as it moved away from the prism was also seen quite often.

(iii) There were many candidates whose answers did not relate to the question or were too vague. However, stronger candidates answered correctly.

(b) (i) Only stronger candidates answered this correctly and many candidates drew a ray that only separated from the red ray as it returned to the air.

(ii) Only a minority of candidates gave answers that related to the question asked. Many candidates stated that the speed of light in glass was greater for higher frequency light and explanations very commonly attempted to use the equation $v = f\lambda$ as part of the explanation.

Question 9

(a) (i) This was often correct. Incorrect answers sometimes had the correct numbers reversed or were some combination of 5 and 3. The numbers should have been to the left of the symbol *Li*.

(ii) Only a minority of candidates drew a diagram such as the one in **Fig. 9.1** and when such a diagram was drawn, the number of shaded and plain circles was only occasionally correct.

(b) (i) The word *random* was rarely used by candidates and when it was, it was occasionally applied to the numbers themselves rather than to the decay process.

(ii) Many candidates were able to suggest a source of background radiation. However, some answers, did not match the context.

(iii) The most common answer that candidates gave was 55. This ignored the background radiation but dealt with the halving correctly. Some candidates who obtained the correct numerical value, supplied the unit *counts / second*.

PHYSICS

Paper 0972/51
Practical Test

Key messages

- Candidates need to have had 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 will 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 regular experience of similar practical work. Some candidates appear to have learned sections from the mark schemes of past papers and written responses that were not appropriate to the questions in this question paper.

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

It is expected that numerical answers will be expressed to a number of significant figures which is appropriate to the data given in the question or a measurement carried out by the candidate.

Comments on specific questions

Question 1

(a) The majority of candidates successfully recorded the *a* and *b* values. Some appeared to have misread the rule. Calculations of *a*/*b* were negotiated successfully by most candidates resulting in decreasing values given to two or more significant figures.

(b) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates ignored the advice '*you do not need to begin your axes at the origin*' and chose a scale that resulted in the plots occupying too small a proportion of the graph grid. Plotting was generally accurate. Candidates should use neat crosses for the plots, or neatly circled dots so that the accuracy of the plotting can be assessed. 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, usually by forcing the line to go through the origin or false origin.

(c) In this question candidates needed to clearly show the triangle method on the graph. Many candidates achieved this. Credit was awarded to those candidates who drew a triangle that used at least half of the line between the extreme plots.

(d) The correct value of W was equal to the value of G and was expected to be given to 2 or 3 significant figures. Further credit was awarded to those candidates who gave the unit N.

Question 2

(a) (i) Most candidates recorded the potential difference to at least 1 decimal place and the current to at least 2 decimal places. Few candidates recorded an unrealistic potential difference or current.

(ii) Most candidates calculated the resistance correctly.

(b) In this question most candidates recorded sensible readings showing that they had correctly set up the circuit. When this was the case, I_2 was less than I_1.

(c) Credit was awarded for recording the values showing that R_3 was less than $3 \cdot R_1$.

(d) In this question candidates were required to make a judgement based on their own results. The justification needed to be clear and consistent with the results to gain credit. Most candidates gained at least partial credit but many merely explained that $3 \cdot R_1$ was greater than R_3 without showing any understanding of the concept of results being beyond the limits of experimental inaccuracy.

(e) Most candidates drew the three lamps in parallel. One voltmeter in parallel with the lamps was often seen but the correct symbol for a variable resistor was less well-known.

Question 3

(a) Most candidates recorded a realistic value for room temperature.

(b) Many completed tables were seen with the expected pattern of results. Some candidates recorded room temperature at time $t = 0$ in place of the initial hot water temperature. Some candidates recorded readings at 30 s intervals instead of 60 s intervals as required in the question. A consistent use of significant figures was expected for the temperature readings.

(c) Most candidates calculated the temperature decreases correctly.

(d) (i) Here candidates were required to make a judgement based on their own results.

(ii) The justification needed to be clear and consistent with the results to gain credit. Correct reference to the temperature differences and time intervals were required.

(e) Successful candidates were able to analyse the question well and to give relevant answers such as use of insulation and use of a lid. Some candidates appeared to be relying on answers they had learned from past papers that were not appropriate for this question. For example, suggesting that room temperature should be kept constant.

(f) Most candidates correctly drew a line perpendicular to the surface of a measuring cylinder to show the line of sight. Fewer included sufficient detail to show that the reading should be taken at the bottom of the meniscus.

Question 4

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

Candidates were expected to realise that the balls would move from left to right and back again along the track as viewed in **Fig. 4.1**.

Candidates were expected to briefly describe releasing a ball from a set position on the track and to measure the time taken for the ball to come to rest. This was then to be repeated several times with one factor being changed each time. Most chose to use balls of different masses but varying the curvature of the track was an alternative approach. In either case candidates needed to be clear about the possible variables that were kept constant.

The table needed to include columns for mass (or the alternative variable chosen) and time with appropriate units.

Candidates were expected to explain how to reach a conclusion from their readings. The most straightforward response was to suggest a graph of mass (or the alternative variable chosen) against time. Candidates should be aware that they are being asked how to reach a conclusion and not to make a prediction about expected results.

PHYSICS

Paper 0972/61
Alternative to Practical

Key messages

- Candidates need to have had 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 will need to be based on data from the question and 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 unusual 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
- 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. This examination should not be seen as suggesting that the course can be fully and effectively taught without practical work. Some of the skills involved in experimental work, including graph plotting and tabulation of readings, can be practised without doing experiments. However, there are parts of this examination in which the candidates are asked to answer from their own practical experience.

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

The practical nature of the examination should be kept in mind when explanations, justifications or further developments are asked for. For example, see **Questions 1(e)**, **1(f)**, **2(c)** and **3(e)**.

It is expected that numerical answers will be expressed to a number of significant figures which is appropriate to the data given in the question or a measurement carried out by the candidate.

Comments on specific questions

Question 1

(a) (i) Many candidates appeared to have measured the distance *b* on the diagram which was not what the question asked for.

(ii) The calculation of *a*/*b* was carried out successfully by most candidates.

(b) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates ignored the advice that they didn't need to begin the axes at the origin and chose a scale that resulted in the plots occupying too small a proportion of the graph grid. Plotting was generally accurate. 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 whilst others drew a straight line that did not match the plots, usually by forcing the line to go through the origin or false origin.

(c) Here candidates needed to clearly show the triangle method on the graph. Many candidates achieved this. Further credit was awarded to those candidates who drew a triangle that used at least half of the line between the extreme plots.

(d) The correct value of *W* was equal to the value of *G* and was expected to be given to 2 or 3 significant figures. Further credit was awarded to those candidates who gave the unit N.

(e) Candidates were expected to explain that the rule should be balanced on the pivot with no load and that the centre of mass is then at the balance point. A significant number of those who did this did not add the detail required for full credit.

(f) Candidates were expected to record an aspect of the experiment that proved difficult in practice. Many sensibly chose to comment on the difficulty of achieving balance or the problem of the loads obscuring the reading on the rule.

Question 2

(a) (i) Most candidates recorded the potential difference and the current correctly and also included the appropriate units.

(ii) Most candidates calculated the resistance correctly.

(b) Here, the majority of candidates calculated the resistance correctly and included the unit Ω.

(c) In this question candidates were required to make a judgement based on the results. The justification needed to be clear and consistent with the results to gain credit. Most candidates gained partial credit, but many merely explained that $3 \times R_1$ was greater than R_3 without showing any understanding of the concept of results being beyond the limits of experimental inaccuracy.

(d) Most candidates drew the three lamps in parallel. One voltmeter in parallel with the lamps was often seen but the correct symbol for a variable resistor was less well known.

Question 3

(a) Most candidates recorded room temperature correctly.

(b) (i)&(ii) Many completed tables were seen with the expected time values and units. Some candidates recorded readings at 30 s intervals instead of 60 s intervals as required in the question.

(c) Most candidates calculated the temperature decreases correctly.

(d) (i) Here candidates were required to make a judgement based on the results.

(ii) The justification given needed to be clear and consistent with the results to gain credit. Correct reference to the temperature differences and time intervals were required.

(e) Successful candidates were able to analyse the question well and to give relevant answers. Use of insulation and use of a lid was often seen, for example. Some candidates appeared to be relying on answers they had learned from past papers that were not appropriate for this question. For example, some suggested that room temperature should be kept constant.

(f) Most candidates correctly drew a line perpendicular to the surface of a measuring cylinder to show the line of sight. Fewer included sufficient detail to show that the reading should be taken at the bottom of the meniscus.

Question 4

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

Candidates were expected to realise that the balls would move from left to right and back again along the track as viewed in **Fig. 4.1**. They were expected to briefly describe releasing a ball from a set position on the track and to measure the time taken for the ball to come to rest. This was then to be repeated several times with one factor being changed each time. Most chose to use balls of different masses but varying the curvature of the track was an alternative approach. In either case, candidates needed to be clear about the possible variables that were kept constant.

The table needed to include columns for mass (or the alternative variable chosen) and time with appropriate units.

Candidates were expected to explain how to reach a conclusion from their readings. The most straightforward response was to suggest a graph of mass (or the alternative variable chosen) against time. Candidates needed to be aware that they were being asked how to reach a conclusion and not to make a prediction about expected results.