

PHYSICS

Paper 0972/11
Multiple Choice (Core)

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

General comments

In some numerical questions, it was clear that some candidates had used trial and error to find a combination of the data that would produce one of the answers regardless of the logic or otherwise of such a combination.

Comments on specific questions

Question 1

Some candidates only read as far as 'average' and immediately calculated the average of the three times for 10 swings. If they had read further, they would have found 'one' emboldened, emphasising that they were expected to divide that ten-swing time by ten.

Question 2

Almost all candidates recognised that the right-hand portion of the table indicated a constant speed, but only stronger candidates knew that the increasing speed on the left-hand side indicated acceleration.

Question 3

Nearly all candidates recognised the units of mass and weight, but fewer candidates knew that the conversion factor is 10 N / kg rather than 10 N / g.

Question 5

The moment of a force is found by multiplying the force by its (perpendicular) distance from the fulcrum. Increasing either will increase the moment. Most candidates knew that you had to increase at least one, but a minority realised that you could do it by increasing either.

Question 6

If the object is moving at a constant speed there is no acceleration, and therefore no resultant force. The only diagram showing a resultant force of zero is **A**, which only the strongest candidates chose. **B** and **D**, which were the most popular choices have resultant forces of 2 N to the right and 1 N to the right respectively.

Question 9

The most popular response was **D**, that nuclear power stations release large quantities of carbon dioxide. Nuclear power may have many disadvantages, but the overwhelming point in its favour is precisely that it doesn't release carbon dioxide.

Question 11

Weaker candidates often thought that the area of a pond affects the pressure at the bottom, whereas stronger candidates recognised that only the depth and density matter. Pascal's vases is a well-known apparatus to demonstrate this fact.

Question 14

Many candidates chose **A**, perhaps imagining that the scale divisions on a liquid-in-glass thermometer that have numbers printed by them (typically at 10°C, 20°C, 30°C, etc.) are the fixed points.

Question 17

Syllabus statement 2.3.2 is quite specific in relating convection to density changes. However, many candidates chose one of the distractors.

Question 18

When answering this kind of question, candidates should tick correct statements and to put crosses by incorrect statements. Only then, when they have dealt with the physics, should they consider the logic of the responses, deciding which response matches their pattern of ticks and crosses.

Question 20

Most candidates thought that the image lies in the plane of the mirror and only a minority recognised that it lies as far behind the mirror as the object is in front.

Question 21

Option **B** was commonly selected by the weakest candidates but was incorrect.

Question 22

The key to this question was to know the regions of the electromagnetic spectrum in order, and so to identify S as visible light. A further clue was provided by it being the only region with a very narrow range of wavelengths. A common misconception was to suppose that mobile phones use radio waves rather than the microwaves that are explicitly stated in section 3.3 of the syllabus.

Question 23

Only the strongest candidates were aware that all electromagnetic waves have the same speed in vacuo.

Question 26

The most reliable way to answer this type of question is to evaluate all three currents, writing their values next to the table, thereby dealing with the physics. Then candidates should look at the logic of the options, taking great care to work from smallest to largest (in this case) rather than the other way round.

Question 27

There was evidence of guesswork here from the weaker candidates. Syllabus section 4.2.3 is explicit about the answer.

Question 29

Stronger candidates were able to answer this correctly.

Question 30

Section 4.3.3 of the syllabus asks candidates to describe the action of a variable potential divider. However, many candidates thought that an increased p.d. across the lamp would result in less brightness or vice versa (options **B** and **C**).

Question 31

Many candidates were able to answer this correctly.

Question 32

Despite the similarity between the circuit symbols for a buzzer and a bell, many candidates made the right choice and answered correctly.

Question 33

There is a difference between preventing a short circuit and protecting against the consequences of a short circuit, so option **B** was incorrect. Fuses generally prevent too high a current in the next stretch of cable, so option **D** was the right answer.

Question 35

Candidates should be familiar with the right-hand grip rule: that if you grip a straight conductor in the right hand with the thumb indicating the direction of conventional current, then the fingers will indicate the direction of the surrounding magnetic field. Not all candidates knew this.

Question 36

Stronger candidates were successful here, while weaker candidates appeared to guess.

Question 38

Even quite strong candidates chose the lead screen, which would be pointless since the alpha particles will be absorbed by the air long before they reach it. The correct answer is to use tongs since they will prevent the hand penetrating the danger zone within 3 cm or so of the source. Keeping a good distance away from a radioactive source is always the best protection.

Question 39

Only the strongest candidates were able to deal with this graphical analysis.

PHYSICS

Paper 0972/21
Multiple Choice (Extended)

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

General comments

Many candidates performed well on this paper with stronger candidates answering the more challenging questions well.

Comments on specific questions

Question 5

This question proved quite challenging, with only stronger candidates being successful.

Question 7

This question, too, challenged all but the strongest candidates.

Question 9

Candidates needed to realise that if the force is applied in the direction that it is already moving, then the object will get faster and so have a higher kinetic energy. They needed to remember that work done and kinetic energy are both measured in joules and may be added.

Question 11

Some candidates did not use g , while others did not subtract the two heights.

Question 14

The sensitivity of a liquid-in-glass thermometer is a measure of how far the thread moves along the capillary tube for a given change of temperature irrespective of how long it takes to do so. Many candidates thought that sensitivity was a question of rapidity of response.

Question 17

Only stronger candidates answered this correctly. Other candidates did not notice that the 3000 crests passed by in a minute rather than in a second.

Question 20

Many candidates thought that the image lies in the plane of the mirror and only a minority recognised that it lies as far behind the mirror as the object is in front.

Question 29

Many candidates calculated the power rather than the energy delivered.

Question 30

The most popular choice was **A**, indicating that candidates thought that the diode has no effect whatever. However, stronger candidates were successful in choosing option **C**.

Question 32

Despite the similarity between the circuit symbols for a buzzer and a bell, many candidates made the right choice here and answered correctly.

Question 33

Weaker candidates found this question about logic gates challenging. The only way the final OR can have an output of 0 is if both of its inputs are 0, which in turn means that both X and Y need to be 1. This is the function performed by a NAND gate, i.e. option **D**

Question 37

Weaker candidates were very unsure about Rutherford's scattering experiment, or the deductions made from it.

PHYSICS

Paper 0972/31
Theory (Core)

Key messages

Apart from basic matters of learning, there were further aspects where candidates could have improved their performance.

- In calculations, candidates must set out and explain their working correctly. When candidates give an incorrect final answer and no working is shown, it is often impossible for partial credit to be awarded for any correct working.
- Greater clarity and precision is required 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

Many candidates were well prepared for this paper. Equations were generally well known by stronger candidates, but a significant number of other candidates struggled to even 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 became confused and displayed a lack of breadth of understanding. Weaker candidates had difficulty in applying their knowledge to new situations, did not show the stages in their working and did not think through their answers before writing.

Many calculations were well set out but there were some candidates who were not clear. Another problem that a minority had was in transposing equations. They regularly started with a correct formula but could not always translate this into correct use of the data in the question.

The questions on levers, advantages and disadvantages of using natural gas as an energy source and explaining the action of a potentiometer in a circuit were generally not well answered. Many candidates either did not read the questions carefully or gave answers that were related to the topic being tested but, did not answer the question in enough detail to receive credit.

The English language ability of the majority of the candidates was adequate for the demands of this paper. There were a very small number of candidates who struggled to express themselves adequately.

The vast majority of candidates indicated by their knowledge and skills that they were correctly entered for this Core Theory paper. A small minority of candidates found the subject matter and level of some questions very straightforward and would have been better entered for the Extension paper.

Comments on specific questions

Question 1

- (a) Most candidates gave the correct answer of 21 cm^3 .

- (b) This calculation was done well by many candidates who gave the correct answer of 0.2 cm^3 . With error carried forward from the previous question many candidates gained full credit. Weaker candidates did not read the question carefully and divided 25 cm^3 by 20.
- (c) Responses to this question were generally good. Some weaker candidates just stated “take the reading on the measuring cylinder” when they needed to say that they were measuring a volume.

Question 2

- (a) Almost all candidates gained full credit on this question. Weaker candidates added the two forces instead of subtracting. A small number gave the direction as East with no indication on the diagram of what was meant by East.
- (b) (i) Many candidates simply wrote a copy of the stopwatch screen. Centres should encourage candidates to use stopwatches in practical exercises, such as determining the speed of sound, and to practise changing the display reading into a time in seconds.
- (ii) This calculation was answered well by most candidates. A small number started with the correct equation of $\text{speed} = \text{distance} \div \text{time}$ but managed to rearrange this so that they divided 12.8 by 200 rather than $200 \div 12.8$.
- (c) Only stronger candidates gained full credit for this question. Candidates should be encouraged to practise calculating the area below speed-time graphs when the area is a trapezium shape.

Question 3

- (a) The vast majority of candidates gained full credit. The most common error was starting with an incorrect arrangement of the equation. This was usually $\text{moment} = \text{force} \div \text{distance}$.
- (b) (i) Only stronger candidates answered this fully correctly. Candidates should be encouraged to practice writing energy transfer equations for common situations or appliances.
- (ii) This item was slightly better answered than (i) but many candidates displayed a lack of understanding of useful and non-useful energy transfers.

Question 4

- (a) The majority of candidates calculated the weight in newtons correctly, but a significant number divided by 10 or multiplied by 1000.
- (b) Only stronger candidates answered this correctly. Most candidates did not realise that the work done on the mass was equal to its increase in gravitational potential energy.
- (c) This calculation was done well by the majority of candidates who evaluated $P = F/A$ to give the correct answer. Only a few candidates used an incorrect rearrangement of the equation. Many candidates gave the correct unit but a significant number gave the unit as Pascals (Pa).

Question 5

- (a) (i) The majority of candidates correctly calculated the difference in height between the two levels of mercury in the manometer. However, many did not know what to do with this value of 120 mm of Hg. Common errors included $760 \div 120$, 760×120 and $760 - 120$.
- (ii) There were many candidates who correctly identified the mercury manometer. Common errors included barometer and thermometer.
- (b) (i) Many candidates did not give a simple kinetic theory model of how a gas exerts a pressure on a surface. Few candidates mentioned molecules in air moving at high speed or molecules colliding with the cylinder.
- (ii) Many candidates recognised that the pressure decreased but far fewer went on to link this with the reduced rate of collisions with cylinder wall or even with fewer collisions with cylinder wall.

Question 6

- (a) (i) Many candidates recognised the effect as refraction but almost as many stated diffraction or even reflection. Centres should encourage candidates to watch demonstrations, possibly on the internet, of the use of ripple tanks to display reflection, refraction and diffraction effects.
- (ii) There were many answers deserving full credit that showed a good grasp of the relevant science.
- (b) Many candidates answered fully and correctly.
- (c) (i) Most candidates gave a correct example of a transverse wave. Weaker candidates gave a longitudinal wave.
- (ii) There were many answers that gained full credit and showed a good grasp of the relevant science. Weaker candidates tended to talk about particles moving up and down or side to side.

Question 7

- (a) Many candidates recognised that the bar was a magnetic material that was magnetised (or a magnet) which they knew because the same end of the metal bar was attracted by the N pole and repelled by the S pole.
- (b) Only stronger candidates gave a clear description of a sensible method for plotting the magnetic field, giving sufficient detail for someone to be able to follow. However, there were many candidates whose knowledge of magnetism was limited to roughly what the field around a magnet looks like and the laws of attraction and repulsion, and no further.

Question 8

- (a) Most candidates answered this well. This topic was well understood by the majority of candidates, but many would have benefited from even more practice to avoid drawing lines through symbols. The most common mistake was an incorrect battery symbol.
- (b) The majority of candidates gave a correct answer, but a significant number chose protons instead of electrons or just put “charges”.
- (c) This calculation was done well by most candidates, with the vast majority of these arriving at a correct solution of 6.0 V. Some candidates started with the correct equation of $V = I \times R$ but rearranged this so that they divided 15 by 0.4. A more common error was to start with an incorrect arrangement of the equation, usually $V = I \div R$. Centres should recommend to candidates that they commit to memory all the equations in the specification.

Question 9

- (a) (i) Many candidates recognised that the fuse protects the transformer or wiring from fire or overheating but answers from weaker candidates were often too vague to gain credit.
- (ii) Many candidates gave a good description of how a fuse works. However, weaker candidates tended to talk about electricity or power rather than the electric current in the fuse.
- (b) The transformer calculation was very well answered by many candidates. The most common error was an incorrect equation as the starting point. Candidates who started with the correct equation sometimes made errors in rearranging the equation.
- (c) (i) Many candidates correctly gave iron as a suitable material for the transformer core. Weaker candidates thought the core was made from wood.
- (ii) Many candidates correctly gave copper as a suitable material for the coils of a transformer. A common mistake was to have the answers for (i) and (ii) transposed.

- (iii) Many candidates answered this correctly and displayed a good understanding of step-down transformers. Weaker candidates merely stated that it was something to do with the coils.

Question 10

- (a) There were many candidates who were awarded partial credit, but only stronger candidates were awarded full credit. Weaker candidates showed a lack of knowledge on this part of the specification.
- (b) The vast majority of candidates gained partial credit here, but stronger candidates answered fully correctly. Common errors included 147 for the nucleon and having the nucleon and proton numbers transposed.
- (c) Many candidates found this question challenging. The topic of half-life was not well understood by many candidates. Very few candidates attempted to determine the number of half-lives that had passed in 28 years. Those that correctly stated that 28 years was equivalent to 2 half-lives then did not know how to use this information. The most common approach was to divide the number of atoms by 2.

PHYSICS

Paper 0972/41
Theory (Extended)

Key messages

Many numerical answers were given with either an incorrect unit or without a unit being supplied. Most of the measurable quantities in the subject content that need to be understood require an SI unit.

Candidates need to be able to rearrange equations and to conduct calculations correctly. Subtracting a negative number or dividing by a number in standard form with a negative exponent was problematic for some candidates.

In discursive questions, candidates need to ensure that the comments made are relevant, are accurate and do not contradict what has already been stated either in the answer or in the question itself.

Although some questions use terms that are directly related to the appropriate learning object in the syllabus, there are always questions set in an unusual context and where the appropriate approach is not stated as explicitly in the wording.

General comments

There were some strong responses this session and many candidates answered well. Occasionally candidate responses were not clearly written. Candidates should be reminded to ensure their responses are legible and clearly set out in the appropriate place on the question paper.

Comments on specific questions

Question 1

- (a) This was quite often answered well, and many candidates were awarded full credit here.
- (b) (i) Many candidates gave the correct final answer and gained credit for it. Sometimes the correct numerical answer did not include an appropriate unit. The unit kg m/s was acceptable but occasionally, this was given as kg/m/s which was incorrect.
- (ii) Some candidates stated that it was block B that was being discussed and, in many cases, what was described applied to neither block. Many candidates stated that the kinetic energy of block A decreased but a common error was to add that it was transferred to gravitational potential energy. Friction was rarely referred to in the explanation.

Question 2

- (a) (i)(ii) Both of these two parts were very well answered and full credit was awarded very frequently. Sometimes candidates suggested force as one of the two other vectors. That force is a vector is given in the initial text and candidates needed to keep in mind the context of the question.
- (b) (i) This part was well answered and the correct numerical value was very frequently supplied. This was not always followed by a unit.
- (ii) Many candidates referred to or described the elastic limit. This was close to but not the same as the limit of proportionality. There were many correct values for the appropriate weight but 12.0 N was also commonly seen.

- (iii) Although some candidates worked their way through to a correct final answer, others made errors and did not gain full credit. A common approach was to identify a point on the line of the graph and to divide a weight by the corresponding length of the spring rather than the corresponding extension of the spring.

Question 3

- (a) This was very often correct, but some candidates incorrectly gave 62 kg 620 J or another incorrect answer.
- (b) Many candidates were able to give at least one appropriate condition for equilibrium, but fewer gave two. Some incorrect answers referred to the centre of gravity being with the base area or made reference to some property of the climber.
- (c) (i) This calculation was often correct, but some candidates used an incorrect distance or unit.
- (ii) Many candidates found this question challenging and some made no attempt at it. Candidates who attempted to balance the moments often made some progress but only the strongest candidates supplied a correct final answer.

Question 4

- (a) (i) This was often answered well with candidates giving a correct numerical value. A small number of candidates rearranged the expression $p = F / A$ incorrectly and obtained $F = p / A$. This did not lead to the correct value.
- (ii) This part was also answered well, and the correct final answer was often seen. A common error was the use of 0.21 m rather than 0.021 m and some candidates divided the force from (i) by the distance. It is not obvious what misunderstanding led to this error.
- (b) The calculation here was quite often correct. Where the final answer was incorrect, this was sometimes due to the use of a temperature difference of 3.0°C or because of an attempt to apply $E = mc\Delta T$.
- (c) This part was not well understood but many candidates were able to make a correct reference to the reduced speed or kinetic energy of the molecules or to indicate that the pressure was the result of molecular collisions with the interior surface of the cylinder. The cancellation of the effects of the reduced speed and of the increased collision frequency was rarely seen.
- (d) Candidates often referred to the greater distances between the molecules of a gas or to the greater intermolecular forces acting in a solid, but few candidates made both points and were awarded full credit.

Question 5

- (a) Many candidates supplied the answer of microwaves rather than infrared radiation, and other components of the electromagnetic spectrum were also seen in responses. There were also candidates who used other terms such as convection or radioactivity.
- (b) (i) Candidates who realised that the two waves were electromagnetic were often able to supply a similarity.
- (ii) Although answers such as different frequencies were accepted, an incorrect relationship was not and this part was less well answered than the previous part.
- (c) (i)(ii) These two parts were only answered well by stronger candidates and many others merely repeated the question. A significant number of candidates did not describe an experiment at all and of those who did, an experiment that compared the absorption properties of differently coloured surfaces was more often given than what was asked for. Some candidates were not sure what the terms experiment and equally mean. Some candidates used a phrase such as “good absorbers and good emitters” without distinguishing between emission and absorption.

Question 6

- (a) Most candidates answered this correctly. A common incorrect answer was “light of a single colour” and was not credited.
- (b) (i) Few candidates explained why the light does not change direction. References to the angle of incidence and to the angle of refraction were rare and more often candidates tried to offer explanation in terms of total internal reflection.
- (ii) A number of candidates who were able to determine the refractive index were also able to reach the correct final answer. Other candidates were sometimes able to gain partial credit for a correct equation or expression.
- (iii) Few candidates deduced that the critical angle for the blue light is less than that for the red light and that because the angle of incidence has not changed, the angle of incidence is now greater than the critical angle. Answers in terms of refraction out of the block were common.

Question 7

- (a) Only a minority of candidates were able to explain the attraction and contact of the springy strips completely, but partial credit was often awarded for comments that were relevant.
- (b) (i) Many candidates were able to calculate the final answer correctly and were awarded full credit. A common error was not converting kilowatts to watts and so answers were a thousand times too small.
- (ii) Many candidates stated that the use of wires with a large cross-sectional area resulted in a small resistance. However, the fact that this reduction decreases the energy transferred to thermal energy in the wires was not so often referred to. Many candidates merely stated that the reduced resistance would result in a larger current.
- (c) Few candidates were able to complete the circuit diagram, but many gained partial credit for connecting the motor in a circuit that contained the relay switch.

Question 8

- (a) Many candidates repeated what was given in the question and stated that both electromotive force (e.m.f.) and potential difference (p.d.) are measured in volts. Only the strongest candidates answered correctly.
- (b) This was answered more successfully, with most candidates gaining credit for referring to an e.m.f. being the property of a power source.
- (c) (i) This part was very often correct. There was no obvious pattern to answers which did not gain credit.
- (ii) Although the correct final answer was seen regularly, candidates who did not gain full credit were often uncertain as to which resistors were in series and which were in a parallel. Some candidates placed all four in series or all four in parallel and other incorrect combinations were suggested by the calculations carried out.
- (iii) Candidates who gained full credit realised that the answer could be obtained by treating the arrangement as a potential divider. Those who calculated the current were less likely to reach the final answer.

Question 9

- (a) Few candidates were awarded credit for this part. Many candidates contradicted the content of the question and stated that different atoms of naturally occurring gold contain different numbers of neutrons.

- (b)(i)** Some candidates gave answers that suggested that the nuclide notation for a beta-particle is ${}^0_1\text{b}$. This is probably because of an incorrect subtraction of -1 during the calculation.
- (ii)** Most candidates gave the correct answer here but others supplied a count rate from another part of the graph. Of these, the value 390 counts / min was the most frequently given.
- (iii)** Many candidates approached this in the correct way but fewer of these obtained an acceptable value for the half-life. Some candidates did not subtract the background count before halving the value read from the graph and out of those that did, many did not add it back on to the value obtained before using the graph.

PHYSICS

<p>Paper 0972/51 Practical Test</p>

Key messages

- Candidates will need to have experience of 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. This includes:

- 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 clearly had regular experience of similar practical work and much less successfully by those who, apparently, had not. Some candidates appear to have learned sections from the mark schemes of past papers and written responses that are not appropriate to the questions in front of them.

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) Most candidates recorded a realistic value for the length of the pendulum but a significant proportion did not give the reading to the nearest mm.
- (ii) Candidates were expected to give a clear explanation involving the use of a horizontal aid or ensuring that the pendulum bob was just touching the meter ruler.

- (b) The majority of candidates successfully recorded increasing t values, with the first value within the accepted range, and calculated the period T correctly. The T^2 values were expected to be given either all to three significant figures or all to four significant figures.
- (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. 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 although some lost the mark by drawing a 'dot-to-dot' line whilst others drew a straight line that did not match the plots.
- (d) Candidates were expected to show understanding of the reaction time error being a smaller proportion of the time for 20 oscillations than for one oscillation. Some candidates appeared to refer to an average of the times taken for each of 20 separate oscillations.

Question 2

- (a) Most candidates recorded a suitable current to at least two decimal places and a realistic potential difference to at least 1 decimal place. Most candidates successfully calculated the resistance R_1 .
- (b) Candidates were expected to record new values of I and V and obtain a value for R_2 which was less than R_1 showing that the instructions had been correctly followed. The mark for the resistance unit Ω was available here if not contradicted elsewhere.
- (c) Candidates were expected to record new values of I and V and obtain a value for R_3 which was less than R_2 again showing that the instructions had been correctly followed. The value of R_3 was expected to be given to 2 or 3 significant figures.
- (d) Candidates were expected to notice that the brightness of the lamp and the resistance of the lamp both decreased. Some candidates gave answers that contradicted their results.
- (e) The majority of candidates drew the correct symbol for the variable resistor, but some drew a thermistor and others a symbol that was a mixture of the two. The candidates were expected to draw a circuit similar to Fig. 2.1 but with the variable resistor replacing the resistance wire and the flying lead replaced by a normal connecting lead.

Question 3

- (a) Most candidates recorded a realistic room temperature.
- (b) The majority of candidates successfully recorded realistic decreasing temperatures. Some recorded room temperature at time $t = 0$ however.
- (c) Most candidates correctly calculated the decrease in temperature and average rate of cooling.
- (d) Here candidates were required to have a starting temperature within + or -2°C of the temperature in Table 3.1 at 90 s. Most achieved this along with decreasing temperatures in Table 3.2. Candidates were expected to calculate the relevant temperature difference and rate of cooling. Here the mark for the unit for rate of cooling was awarded if correct and not contradicted in **part (c)**. A significant number of candidates either gave no unit or a wrong unit.
- (e) The conclusion must link the initial temperature with the rate of cooling and quote numerical results to support the conclusion. The response must be based on the candidates' results.
- (f) Candidates were expected to give two relevant responses, for example viewing the scale at right angles and taking the reading 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. 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.

A concise explanation of the method is required. Candidates should concentrate 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 describe releasing the ball to roll down the track and then measure how far it travels. An unspecific reference to repeats is not sufficient as it is not clear whether the candidate is referring to using different angles or repeating the measurements with the same angle.

The distance to be measured was the horizontal distance travelled. Some candidates addressed this and gave a good description of how this could be achieved although by having suitable reference points on the floor, maybe using a sand tray to catch the ball and leave a mark at the point it landed. Many candidates missed this level of detail.

Candidates were expected to identify the variable that should be kept constant – the release height or using the same ball every time.

Many candidates drew a suitable table. They were expected to include columns appropriate to the method including correct units.

Candidates were expected to explain how to reach a conclusion by drawing a graph of angle against distance travelled or by comparing the angle with the distance. 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 will need to have experience of 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

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- 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 clearly had regular experience of similar practical work and much less successfully by those who, apparently, had not. Some candidates appear to have learned sections from the mark schemes of past papers and written responses that are not appropriate to the questions in front of them.

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) Candidates were expected to give a clear explanation involving the use of a horizontal aid or ensuring that the pendulum bob was just touching the meter ruler.
- (b)(i),(ii) The majority of candidates successfully calculated the period T correctly. The T^2 value was expected to be correctly rounded and given to two decimal places.
- (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. 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 although some lost the mark by drawing a 'dot-to-dot' line whilst others drew a straight line that did not match the plots.

- (d) Candidates were expected to show the triangle method clearly on the graph and use a large triangle.
- (e) Candidates were expected to show understanding of the reaction time error being a smaller proportion of the time for 20 oscillations than for one oscillation. Some candidates appeared to refer to an average of the times taken for each of 20 separate oscillations.

Question 2

- (a) Many candidates drew the correct symbol across the lamp but others placed the voltmeter in series with the lamp or across the resistance wire.
- (b)(i),(ii) Most candidates recorded the correct potential difference and current readings and went on to successfully calculate the resistance R_1 .
- (c) The value of R_2 was expected to be given to 2 or 3 significant figures. Candidates were expected to record new values of I and V and obtain a value for R_2 which was less than R_1 showing that the instructions had been correctly followed.
- (d) The mark for the resistance unit Ω was available here if not contradicted elsewhere.
- (e) Candidates were expected to realise that the brightness of the lamp and the resistance of the lamp both decreased. Some candidates gave an answer that contradicted their results.
- (f) The majority of candidates drew the correct symbol for the variable resistor, but some drew a thermistor and others a symbol that was a mixture of the two. The candidates were expected to draw a circuit similar to Fig. 2.1 but with the variable resistor replacing the resistance wire and the flying lead replaced by a normal connecting lead.

Question 3

- (a) Most candidates recorded the correct room temperature, 23°C, but some quoted 20.3°C.
- (b) The majority of candidates successfully recorded the times.
- (c) Most candidates correctly calculated the decrease in temperature and average rate of cooling but a significant number of candidates either gave no unit or a wrong unit.
- (d) Most candidates correctly calculated the decrease in temperature and average rate of cooling.
- (e) The conclusion must link the initial temperature with the rate of cooling and quote numerical results to support the conclusion. The response must be based on the candidates' results.
- (f) Candidates were expected to give two relevant responses, for example viewing the scale at right angles and taking the reading at the bottom of the meniscus.
- (g) Two relevant variables were expected. For example the volume of water and room temperature.

Question 4

Candidates who followed the guidance in the question were able to write concisely and address 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.

A concise explanation of the method is required. Candidates should concentrate 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 in order to address the subject of the investigation. Candidates were expected to describe releasing the ball to roll down the track and then measure how far it travels. An unspecific reference to repeats is not sufficient as it is not clear whether the candidate is referring to using different angles or repeating the measurements with the same angle.

The distance to be measured was the horizontal distance travelled. Some candidates addressed this and gave a good description of how this could be achieved although by having suitable reference points on the floor, maybe using a sand tray to catch the ball and leave a mark at the point it landed. Many candidates missed this level of detail.

Candidates were expected to identify the variable that should be kept constant – the release height or using the same ball every time.

Many candidates drew a suitable table. They were expected to include columns appropriate to the method including correct units.

Candidates were expected to explain how to reach a conclusion by drawing a graph of angle against distance travelled or by comparing the angle with the distance. The question did not ask for a prediction. Some candidates wrote a prediction but no explanation of how to reach a conclusion.