PHYSICS

Paper 0625/12
Multiple Choice

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

General comments

Candidates found many of the questions on this paper challenging. However, some of the questions were well answered.

Comments on specific questions

Question 2

Some candidates believed that an object falling without significant air resistance experiences increasing acceleration but has a constant velocity. Candidates need to be clear about the meaning of these two terms.

Question 4

A common error was to indicate that energy and power have the same unit, but not work.

Question 9

Option D was popular as the key. Candidates should be able to distinguish between total energy and kinetic energy.

Question 12

A high proportion of candidates chose option A; candidates need to ensure that they are familiar with the simple mercury barometer.

Question 16

Some candidates incorrectly selected option B. Candidates should ensure that they do not confuse thermal capacity with latent heat of fusion.

Question 21

Candidates found this question challenging. Candidates should know that neither the speed nor the wavelength of the waves changes when diffraction occurs.

Question 22

Candidates need to be familiar with the unit of wavelength; many incorrectly chose hertz or metre per second.

Question 25

Option B was a popular choice for many candidates.

Question 26

Many candidates chose option A. Candidates should be able to distinguish between wavelength and frequency.

Question 30

A common misconception was that thinner wires have smaller resistance.

Question 32

Option D was chosen by many of the candidates. Candidates must ensure that they understand the difference between series and parallel connections of resistors.

PHYSICS

Paper 0625/22
Multiple Choice

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

General comments

Several questions were well answered, particularly questions **1**, **2**, **4**, **5**, **8**, **14**, **22** and **28**. Candidates found questions **3** and **15** more challenging.

Comments on specific questions

Question 3

Stronger candidates gained credit in this question on falling and acceleration.

Question 6

This question concerned centripetal force and caused little difficulty for the majority of stronger candidates. Candidates who answered incorrectly generally selected option A (the instantaneous direction of motion).

Question 9

Candidates who performed strongly overall often chose option B as correct, incorrectly indicating that oil is not derived from the Sun. Candidates need to be clear about which energy resources are derived from the Sun.

Question 15

Many of the responses were incorrect, with many candidates choosing option D. Although a high proportion of candidates knew that there was an inverse relationship between pressure and volume, many were not aware that the graph to show inverse proportion is a curve. Candidates should be able to recognise a relationship showing inverse proportion from a graph.

Question 33

A number of weaker candidates chose option C; possibly they considered the effect of decreased resistance on current (rather than on p.d.).

PHYSICS

Paper 0625/32
Core Theory

Key Messages

Candidates should practise applying their knowledge to new situations by attempting questions in support materials or exam papers from previous sessions.

In calculations, candidates must show clear working to support their answers. If unclear or no working is shown by the candidate and it leads to the correct answer, due credit can be given for the numerical answer. However, when a candidate makes an error that leads to an incorrect numerical answer and no working is shown, credit for the method cannot be awarded.

Candidates are advised to read the questions carefully, and underline key words.

General Comments

Equations were generally well known by many candidates.

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, some were confused and displayed a lack of breadth of understanding. More successful candidates were willing to think through the possibilities and apply their knowledge when the question asked for suggestions to explain new situations.

Comments on Specific Questions

Question 1

(a),(b) The majority of candidates determined the volume and the mass of the sand.

(c) Most candidates correctly calculated the density of sand. The most common error was to write an incorrect equation for calculating density.

(d) Most candidates were awarded full credit. Weaker answers gave explanations in terms of gold mixing with the sand.

Question 2

(a) (i) The majority of candidates determined the correct distance from the graph.

(ii) The majority of candidates gained most of the available credit. A common mistake was failing to convert the time from minutes to seconds, or using an incorrect time from the graph.

(b) The majority of candidates scored full credit.

Question 3

(a),(b) The majority of candidates scored full credit.

(c) Only the strongest candidates gained the majority of the available credit. Most candidates merely described what would happen as the boy moves, and failed to give any explanation in terms of moments.

Question 4

(a) Most candidates were awarded credit. The most common mistake was to only give a description for part of the day.

(b) The strongest candidates scored full credit. Weaker candidates did not link the ideas of temperature increase, increased molecular motion and more frequent or harder collisions with the wall of the balloon.

Question 5

(a) This was one of the best-answered questions on the paper, with the majority of candidates gaining full credit.

(b) Candidates found this a challenging question. The majority of candidates only gave one or two benefits of renewable energy sources, and weaker candidates merely listed other examples of renewable energy sources.

Question 6

(a) (i)&(ii) Most candidates gained full credit. Weaker candidates did not name the normal line and did not identify the angle of reflection.

(b) (i) Most candidates were awarded credit. A common error was to use the colour purple instead of indigo.

(ii) The strongest candidates gained most of the available credit on this question. The majority of candidates did not recognise that total internal reflection would take place because the angle of incidence had increased beyond the critical angle for the semi-circular glass block.

Question 7

(a) Many candidates recognised that hot air rises, but very few linked this to an expansion of the air or a decrease in the density of the air.

(b) The strongest candidates gained most of the available credit for this question. However, very few candidates linked the properties of aluminium foil as a good reflector or the trapped air as an insulator, reducing thermal energy transfer by conduction and convection.

Question 8

(a) The strongest candidates were able to describe a suitable method for determining the speed of sound in air.

(b) (i) The majority of candidates identified the amplitude of the wave. The most common error was to state it was equal to BE.

(ii) The majority of candidates identified the wavelength of the wave. The most common errors were to state it was either AC or AF.

(iii) The majority of candidates did not follow the instruction to draw the wave on **Fig. 8.1**. Where possible, credit was given for responses drawn in the space below the question. It would be a useful exercise for candidates to practice drawing a wave on top of an existing wave to demonstrate changes in amplitude and frequency.

Question 9

(a) The majority of candidates identified one or two uses correctly.

(b) The majority of candidates scored partial credit for a description of the damage caused by X-ray machines, but only the stronger candidates linked the damage to the fact that X-rays are ionising radiation, or the idea of excessive exposure.

Question 10

(a) Stronger candidates gained full credit, but weaker candidates did not state that similar poles of magnets would repel.

(b) The majority of candidates scored most of the credit available for this question. Some candidates misread the question and tried to explain that nothing would happen when the switch was open.

(c) There were many examples of carefully drawn field patterns, including the correct direction of the magnetic field.

Question 11

(a) (i) Most candidates were awarded the majority of credit for this question. As expected, the most common error was interchanging of the symbols for the ammeter and the voltmeter.

(ii) Most candidates gained full credit for this question. The most common error amongst some candidates was to mis-state the equation for resistance.

(iii) The stronger candidates recognised that the resistance of the lamp would increase.

(b) (i) Most candidates gained full or partial credit for this question.

(ii) Many candidates stated facts that were common to both series and parallel combinations of lamps and therefore could not be awarded credit.

Question 12

(a) Most candidates were awarded the majority of available credit for this question.

(b) (i)&(ii) Most candidates gained full credit on this question. Some candidates thought that the number of neutrons was 210.

(c) Many candidates gained full credit. The most common mistake was to halve the maximum reading on the *y*-axis to give an answer of 9000.

PHYSICS

Paper 0625/42
Extended Theory

Key messages

In numerical questions, credit is usually available for the recall of a formula. Candidates are strongly advised to write down the recalled formula.

In numerical questions for which the command word is 'State', and a single mark is available, candidates can assume that no fresh working is required. The answer required may be the repetition of a previous numerical answer, possibly with a different unit.

General comments

Work of a very high standard was seen on a large number of scripts. The candidates producing this work were able to gain almost all of the credit available in the calculations.

Many candidates also demonstrated considerable ability in many aspects of the questions, but with errors creeping in. Care is required in details of the calculations. Those errors in the non-numerical questions were sometimes caused by misunderstanding of the requirements of a question. In other cases some candidates did not express their ideas accurately, even though their understanding of the theory may have been sound.

Most candidates were able to cope with the parts of the questions set on the Core section of the syllabus and, with varying degrees of success, the more basic calculations.

Comments on specific questions

Question 1

(a) (i) A very small number of candidates failed to write down the correct speed or to add the unit.

(ii) The idea of reaction time or thinking time was conveyed by most of the candidates. Answers referring to thinking distance were not credited.

(b) (i) Those who chose to calculate the acceleration by using the whole of the sloping part of the graph were largely successful. A few attempted to work with a small section of the slope and sometimes read the graph coordinates with less than the required accuracy.

(ii) The area under the graph was required. Some candidates suggested this, or wrote down a formula expressing this idea, and could be awarded partial credit. A majority went on to calculate the correct distance.

Question 2

(a) The numerical value of the change in momentum was calculated correctly in most cases. Mistakes in stating the unit were fairly common however, with kg/m/s often seen.

(b) Many candidates seemed unaware that impulse is change of momentum, so that unnecessary calculations that produced the wrong value of the impulse were common.

(c) Some calculated the deceleration of the hammer head starting with F = ma. Others worked out the force using change of momentum divided by time. Many correct answers were seen.

Question 3

(a) (i) A straight line from the origin was required. Some drew a curve from the origin and others added a curve from the end of the straight line, no credit was awarded here.

(ii) Strain energy and elastic energy were both acceptable, and few wrong alternatives were given.

(b) A high number of correct values for the speed were calculated. A few omitted the unit.

Question 4

(a) Quite a small minority of candidates ticked all three correct boxes, and many ticked geothermal or nuclear or both of these.

(b) (i) A large majority stated that copper is a good conductor and could be awarded credit. The requirement regarding why the tubes are painted black was to say that this surface is a good absorber of radiation, not simply to suggest that it is a good absorber, or a good absorber of heat.

(ii) The formula $Q = mc\Delta\theta$ or $mc\Delta T$ is well known and most candidates used the formula correctly.

(iii) The calculation required the use of the formula relating efficiency to the output and input power or energy. Partial credit was available for stating this formula. The subsequent work required manipulation of the formula and the calculation of the power output, which proved to be challenging for many candidates.

Question 5

(a) (i) Most candidates were able to identify the inverse relationship between pressure and volume. Many, however, have the misconception that the evidence for this is simply that as the pressure increases, the volume decreases. A small minority referred to the data and correctly suggested that doubling the pressure halved the volume, or that the product of pressure and volume was the same for each pair of values, at least to a good approximation.

(ii) Most could identify temperature or, more rarely, internal energy, as the constant property.

(b) (i) The required formula is well known and a large majority gained full credit.

(ii) The most common reward was partial credit for two, or only one, correct boxes ticked.

Question 6

(a) (i) Many candidates correctly labelled both the amplitude and the wavelength. Those who made one error were more likely to have wrongly labelled the amplitude than the wavelength.

(a) (ii) The links between loudness and amplitude and between pitch and frequency are clearly well known by the majority. In **1**, most could identify the amplitude as increasing and the wavelength remaining the same. In **2**, the increase in pitch had to be related to a decrease in wavelength.

(b) A very frequent error was in the conversion of 54 ms to 0.054 s, regarded as a power-of-ten error and resulting in partial credit. In several cases, candidates attempting to make the conversion divided 54 by 60.

Question 7

(a) (i) Candidates were required to state that for total internal reflection, a ray had to be travelling in a more dense medium towards a less dense medium. In general, there was difficulty in using the correct wording in the explanation.

(ii) An important requirement in this case was to make the point that the critical angle is the angle of incidence, not simply “the angle”. Precision in wording was required.

(b) (i) Most candidates were able to write down the correct ratio of speeds to calculate the value 1.5.

(ii) The formula sin c = 1 / n was recalled by a large majority of candidates and used correctly. A significant minority, however, clearly failed to recall the formula and offered no response.

(iii) Surprisingly few candidates could be awarded more than partial credit. The probable explanation is that they did not correctly examine the given prism. They assumed that the behaviour of the ray was what would have been the case with a prism with angles of 45°, 90° and 45°. The credit awarded to most candidates was for showing no change of direction at the left-hand face. Many of those who did show a correct internal reflection at the hypotenuse failed to show a correct or any refraction at the lower face.

Question 8

(a) (i) A large majority of candidates used the formula P = IV correctly.

(ii) Most of these candidates also correctly trebled the answer in **(i)**.

(iii) According to the number of significant figures used, the answers 11 lamps or 10 lamps were acceptable.

(b) (i) Most candidates recalled that decreasing the thickness of a lamp filament increases its resistance.

(ii) The correct connection between the increase in resistance and a decrease in power was usually made, with an error in **(i)** allowed for. For the explanation, a reference to either P = IV or P = V^2 / R was essential.

Question 9

(a) (i) Very few acceptable responses were seen.

(ii) The award of full credit was the norm for drawing the field lines for the uniform field. Only partial credit could be awarded to responses with uneven spacing of the lines or for arrows pointing in the wrong direction.

(b) (i) This question proved challenging. Suggestions of equal upward and downward forces, or no resultant force were awarded partial credit. In explanations for the equilibrium, very few referred to the essential aspect of the weight of the oil drop.

(ii) Most candidates concentrated on explaining the process of evaporation. It was rare to include any reference to a decrease in the mass or weight of the drop, which would have gained credit, or the subsequent upward movement of the drop as the forces became unbalanced.

Question 10

(a) (i) The majority of candidates stated three correct values. Where errors occurred, it was usually in the number of neutrons.

(ii) With clear knowledge of how β-emission changes the atomic number but has no effect on the nucleon number, many candidates stated the required symbol correctly. Others had some idea and stated one or other of the numbers correctly, and were awarded partial credit. A small number of answers gained no credit.

(b) Many candidates handled the data correctly. Full credit was awarded for good quality graphs, with only partial credit gained for straight lines drawn between any pair of plotted points. Those who failed to take the background into account were allowed some credit for plotting points at 50, 100 and 150 s.

Question 11

Each part of this question relied upon recall of learnt material, an ability which was demonstrated to the full by a very large number of candidates. The most common error, if one was made, was in the completion of the truth table in **(a)(ii)**.

PHYSICS

Paper 0625/52
Practical

Key Messages

Candidates will 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 unusual situations. Papers will contain a planning question, requiring candidates to design an experiment to investigate a given brief.

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 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. This was seen in the clear practical details given by some candidates in **Questions 1(a)** and **(b)**, **Question 2(e)** and **Question 3(f)**.

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. This was demonstrated in many good responses to **Question 2(c)** and **Question 3(d)**.

There will be questions in which candidates will be asked to develop techniques that may be referring to unfamiliar situations. These questions will, however, always be able to be answered by careful reading of the brief and the logical application of good experimental practice. A number of candidates showed good practical knowledge when answering **Question 4**.

Comments on specific questions

Question 1

(a) Most gained credit with sensible values for length and diameter and went on to calculate V_1 correctly.

Many candidates found the description of a method for measuring *d* challenging. A straightforward diagram or description of blocks on either side of the boiling tube with a ruler measuring the gap between them was seen only in a few responses. In these cases, it was made less ambiguous if a supporting diagram was drawn rather than attempting a description purely in text.

Very few gained credit for a precaution, such as obtaining an average after measuring the diameter in various places along the length of the boiling tube or rotating the tube to other positions. “Repeat measurements” was not seen as a precise enough statement without this qualification. Some correctly mentioned that the rim of the boiling tube should be avoided when positioning the blocks. Although blocks had been provided for this purpose, other reliable methods of measuring diameter were accepted. A small number of candidates used string to measure the circumference and calculated the diameter. A precaution in this case would be to wrap the string around the tube several times and divide by the number of turns to obtain the circumference. Direct measurement across the top of the boiling tube was not credited.

(b) Most candidates were able to obtain a sensible value for V_2. A small number clearly made an error with interpretation of the scale and stated a value which was larger than V_1. It is essential to have a practical understanding of the relationship between values that are being measured. There were a high proportion of good answers to **part (ii)** which mentioned viewing the scale perpendicularly at the lower meniscus level. The vast majority calculated V_3 correctly.

(c) Many candidates obtained a value for density which was in the expected range, giving the correct unit of g/cm^3.

(d) This type of question requires candidates to focus on sources of inaccuracy that are inherent or difficult to avoid in the experiment, rather than identify possible poor practice. Explaining that some drops of water remained in the boiling tube after measuring the volume was acceptable while spilling water or possible misreading of volume were not.

Some candidates gained credit by detailing why the boiling tube should not be considered as a cylinder as it had a curved end and a rim.

Few candidates gained full credit by linking the likely effect on the calculated value of density to the stated source of inaccuracy. However, each part was assessed separately and some were able to explain the effect without being clear enough with the source.

A number quoted “volume” without being specific about which value was being considered. A larger value of V_1 would reduce the calculated value of ρ while an increase in V_2 would produce a smaller value of V_3 and an increase in ρ. A clear, concise explanation of the latter was seen in responses from some of the stronger candidates.

Question 2

Aspects of this question were well done by a number of the stronger candidates. However, sections involving analysis and details of practical methods proved difficult for many.

(a) The majority of candidates obtained 5 increasing current readings expressed to the necessary 2 decimal places. Where meters were provided reading in mA this may have confused candidates when recording the values.

(b) There were a good proportion of well-drawn, accurate graphs with clearly labelled axes. Plotting was mostly correct, many candidates indicated the plots with fine crosses as advised in previous reports to Centres. Small dots are acceptable but are often obscured when the line is drawn through them, making it more difficult to award credit for correctly plotted values. The large dots used by an increasing number of candidates are not acceptable as the intended value cannot be determined clearly. A sharp pencil should be used for the plots and for the line so that accurate drawing may be achieved and errors easily corrected.

Scales were for the most part sensible. Only a few candidates had used impractical scales which almost inevitably meant that additional credit could not be given when determining more difficult positions for plotted points.

A small number of candidates equally spaced the I values on the horizontal axis, producing an inconsistent scale and could not be awarded credit, not only for the scale but also for the plots, as their positions cannot be determined correctly, and the inevitable straight line, as no judgement is required for this.

Many candidates produced a fine, straight, well-judged line of best fit. Only a very few candidates joined the points together and therefore could not be awarded the additional credit. There was a tendency by some candidates to force the line through the origin, ignoring the trend of the plotted points.

(c) Many candidates drew a clear, good sized triangle with which to determine the gradient but some omitted this from the graph.

The resistance value was often within the expected range, with a unit of Ω and expressed to 2 or 3 significant figures. Some candidates ignored the advice in the question and gave a number which was unrelated to the gradient, apparently calculating the resistance from a pair of values in the table.

(d) The strongest candidates were able to explain clearly that proportionality was indicated by a straight line passing through the origin. A number recognised that the latter condition was satisfied if the line passed close to the origin, within the limits of experimental accuracy.

Some candidates incorrectly considered the plotted points rather than the line and suggested that as they did not all lie on the straight line, proportionality was not indicated.

A number referred to the line being “a best-fit” rather than straight. It should be recognised that not all best-fit lines are straight and the terms are not synonymous.

Calculations from the data were not accepted as the question asked for reference to the graph.

A small number of candidates had not extended the line to the origin and this is perfectly acceptable. However, some did not realise that the line would pass through the origin if extended and responded to this question in the negative.

(e) The most common correct answer recommended simply that the current should be reduced, generally by using a smaller potential difference. A few candidates suggested the use of a longer, thinner slide wire or the inclusion of an additional series resistor to achieve the lower current. Incorrect answers referred to the use of a shorter, thicker wire or insulating the slide wire. A common wrong response suggested increasing the potential difference in order that the current would decrease, presumably confusing the situation with transformer theory.

Question 3

This was a question that many candidates were able to answer successfully. The majority appeared to have read the instructions carefully and followed them accurately.

(a) The vast majority of candidates drew the normal well.

(b) Most drew the line **NM** correctly at 20° to the normal. Measuring was generally very accurate and where incorrect incident angles were seen, they were mostly 30° or more, rather than a poorly determined 20°.

(c) Many have 5.0 cm in their minds as the required pin separation. It should be recognised that this is the minimum value expected and that pins should be as far apart as is practically possible for good ray tracing. A number of candidates went for exactly 5.0 cm and risked not gaining credit through slight inaccuracies in measurement or drawing.

(d) The lines were often well drawn and *a* and *b* were measured correctly in many cases. Candidates should be careful not to rush measurements as a number showed errors of ±0.1 cm or transposition by 0.5 cm.

There were many correct calculations of refractive index in the expected range, showing no unit and expressed to 2 or 3 significant figures.

(e) Many of the stronger candidates produced a second set of lines with an incident angle of 40° and a second value for refractive index close to that which had been previously calculated.

(f) Many candidates obtained partial credit for practical precautions. However, it was often the case that precautions quoted here, such as use of thin pencil lines or ensuring that pins were spaced far apart were not observed in the practical part of the question.

A number suggested repeating the experiment (and taking an average value of *n*) but did not include the necessary qualification of 'with different angles', despite having already done this. In this part of the question candidates are prompted to describe precautions they have taken and should draw on their earlier experience.

Question 4

Many candidates did well on this question and showed a sound knowledge of experimental techniques, but some had difficulty in interpreting the required practical approach to investigate the given relationship. The vast majority completed the question.

There were many detailed, clear, coherent plans for practical work which would investigate the relationship between surface area and rate of cooling and a good number of candidates gained full credit on this question. The mark scheme also allowed some credit for descriptions which, although they may not have satisfied the given brief entirely, contained aspects of good practice in thermal energy experiments.

The best responses showed a logical approach, structured as suggested by the question, with concise sentences which communicated ideas well. Candidates can often miss straightforward points if planning is not approached in a sequential way.

The correct required apparatus was often identified, sometimes within the body of the instructions if missing from a list at the start. A stop-watch or other timing device was the most common omission. The use of different sized beakers was the usual means of obtaining containers of different surface areas and it was recognised by many that a range of at least 5 distinct values would be needed to plot a graph. Some good responses mentioned the need for the containers to be similar or of the same material and a number included insulation to ensure that loss of thermal energy from the sides or bottom of the container was minimised. There were, however, references to the use of lids, which meant that credit for the method could not be awarded as it defeated the object of the experiment.

Instructions for carrying out the experiment were often clear but essential steps were sometimes taken for granted. Some candidates did not specify the use of hot water or that water temperature should be measured at given times, merely referring to 'take results'. It was sometimes assumed that the experiment should be repeated for different containers without being stated in the plan.

Precautions such as different containers having the same volume of hot water or the same initial water temperature were often seen. Constant room temperature was also a common correct answer. Care should be taken with these details. Heating water to the same temperature then pouring it into the container to be tested is not necessarily the same as "constant initial hot water temperature", as thermal energy is lost on pouring.

Suggestions for graphs were generally acceptable, most showing temperature against time as a set of cooling curves. Some of the stronger candidates included the calculation of temperature change in a given period or the calculation of cooling rate. These were seen plotted against surface area.

It should be noted that analysis or explanation of possible results, which is generally based on theory is not required in this type of planning experiment.

PHYSICS

Paper 0625/62
Alternative to Practical

Key Messages

Candidates will 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. Papers will contain a planning question, requiring candidates to design an experiment to investigate a given brief.

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 course will be taught so that candidates undertake regular practical work as an integral part of their study of physics. 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 clearly had experience of similar practical work. This was seen in the clear practical details given by some candidates in **Question 1(e)**, **Questions 2(a)** and **(b)** and **Question 3(d)**.

It is expected that numerical answers will include a matching unit and 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. These points were demonstrated in many good responses to **Question 1(c)** and **Question 3(c)**.

There will be questions in which candidates will be asked to develop techniques that may well be referring to unfamiliar situations. These questions will, however, always be able to be answered by careful reading of the brief and the logical application of good experimental practice. A number of candidates showed good practical knowledge when answering **Question 4**.

Comments on specific questions

Question 1

(a) Many candidates showed the readings correctly but a few positioned lines which were too vague to gain credit. Candidates should always extend the line to the scale of the meter to ensure that their intentions are clear.

(b) There were a good proportion of well-drawn, accurate graphs with clearly labelled axes. Plotting was mostly correct, many candidates indicating the plots with fine crosses as advised in previous reports to Centres. Small dots are acceptable but are often obscured when the line is drawn through them, making it more difficult to award the credit for correctly plotted values. The large dots used by an increasing number of candidates are not acceptable as the intended value cannot be determined clearly. A sharp pencil should be used for the plots and for the line so that accurate drawing may be achieved and errors easily corrected.

The given values were straightforward and, as a consequence, scales were for the most part sensible. Only a few candidates had used impractical scales which almost inevitably led to additional credit not being awarded when determining more difficult positions for plotted points.

A small number of candidates equally spaced the I values on the horizontal axis, producing an inconsistent scale and could not be awarded credit, not only for the scale but also for the plots, as their positions cannot be determined correctly, and the inevitable straight line, as no judgement is required for this.

A small but significant number of responses were seen with a horizontal scale based on 2.5 cm = 0.10 A. This ended with a value of 0.40 A and candidates were unable to plot the final set of values.

Many candidates produced a fine, straight, well-judged line of best fit and only a very few were not awarded the credit because they joined the points together. There was a tendency by some to join the first and last points with a straight line, wrongly ignoring the other points which all lay to one side of the line.

(c) Many candidates drew a clear, good sized triangle with which to determine the gradient but some omitted this from the graph.

The resistance value was often within the expected range, with a unit of Ω and expressed to 2 or 3 significant figures. Some candidates ignored the advice in the question and gave a number which was unrelated to the gradient, apparently calculating the resistance from a pair of values in the table.

(d) The strongest candidates were able to explain clearly that proportionality was indicated by a straight line passing through the origin. A number recognised that the latter condition was satisfied if the line passed close to the origin, within the limits of experimental accuracy. Some candidates incorrectly considered the plotted points rather than the line and suggested that as they did not all lie on the straight line, proportionality was not indicated.

Calculations from the data were not accepted as the question asked for reference to the graph.

A small number of candidates had not extended the line to the origin and this is perfectly acceptable. However, some did not realise that the line would pass through the origin if extended and responded to this question in the negative.

(e) The most common correct answer recommended simply that the current should be reduced, generally by using a smaller potential difference. A few candidates suggested the use of a longer, thinner slide wire or the inclusion of an additional series resistor to achieve the lower current. Incorrect answers referred to the use of a shorter, thicker wire or insulating the slide wire. A common wrong response suggested increasing the potential difference in order that the current would decrease, presumably confusing the situation with transformer theory.

Question 2

(a) Most were awarded the measurement credit and gained credit for the subsequent calculation of V_1. However, a small number of candidates gave a range of values for each answer. This will only be acceptable if the question specifically asks for it.

Many candidates found the description of a method for measuring *d* challenging. A straightforward diagram or description of the blocks on either side of the test-tube with a ruler measuring the gap between them was seen only in a few responses. In these cases, it was made less ambiguous if a supporting diagram was drawn rather than attempting a description purely in text.

Many candidates omitted the ruler or placed the blocks inside the test-tube.

Very few gained credit for a precaution, such as obtaining an average after measuring the diameter in various places along the length of the test-tube or rotating the tube to other positions. 'Repeat measurements' was not seen as a precise enough statement without this qualification. Some correctly mentioned that the rim of the test-tube should be avoided when positioning the blocks.

(b) Most candidates were able to read the volume V_2 of 54 cm^3 correctly, with only a minority reading the upper meniscus at 56 cm^3 or misinterpreting the scale and choosing 52 cm^3 or 47 cm^3. There were a high proportion of good answers which mentioned viewing the scale perpendicularly at the lower meniscus level. The vast majority calculated V_3 correctly.

(c) Many candidates obtained a value for density which was in the expected range, giving the correct unit of g/cm^3, and were able to express the mass correctly to the nearest gram. The most common mistakes in the latter were to retain the decimal places as 32.00 g or to round to the nearest 10 grams with 30 g.

(d) This type of question requires candidates to focus on sources of inaccuracy that are inherent or difficult to avoid in the experiment, rather than identify possible poor practice. Explaining that some drops of water might remain in the test-tube after measuring the volume was acceptable while spilling water or misreading of volume were not.

Some candidates gained credit by detailing why the test-tube should not be considered as a cylinder as it had a curved end and a rim.

Few candidates gained full credit by linking the likely effect on the calculated value of density to the stated source of inaccuracy. However, each part was assessed separately and some were able to explain the effect without being clear enough with the source.

A number quoted 'volume' without being specific about which value was being considered. A larger value of V_1 would reduce the calculated value of ρ while an increase in V_2 would produce a smaller value of V_3 and an increase in ρ. A clear, concise explanation of the latter was seen in responses from some of the stronger candidates.

Question 3

This was the question that many candidates were able to answer most successfully. The majority appeared to have read the instructions carefully and followed them accurately.

(a) Most candidates drew the normal well and measured the angle correctly as 40°. Some measured to the block rather than the normal and obtained 50°.

(b) Many have 5.0 cm in their minds as the required pin separation. It should be recognised that this is the minimum value expected and that pins should be as far apart as is practically possible for good ray tracing. A number of candidates went for exactly 5.0 cm and risked not being awarded available credit through slight inaccuracies in measurement or drawing.

(c) The lines were often well drawn and many gained the accuracy credit here for correct *a* and *b* values. While it is acceptable to show the normal as a dotted line, provided that measurement is not made difficult, ray-trace lines should be continuous.

There were many correct calculations of refractive index, showing no unit and expressed to 2 or 3 significant figures.

(d) Many candidates obtained at least partial credit for practical precautions. However, it is important to focus on the experiment being described and avoid quoting from a previously revised list. Use of a darkened room was seen on a number of occasions and this is suitable for lens experiments, not ray tracing.

A number suggested repeating the experiment (and taking an average value of *n*) but did not include the necessary qualification of 'with different angles'.

Question 4

Many candidates did well on this question and showed a sound knowledge of experimental techniques, but some had difficulty in interpreting the required practical approach to investigate the given relationship. The vast majority completed the question.

There were many detailed, clear, coherent plans for practical work which would investigate the relationship between surface area and rate of cooling and a good number of candidates gained full credit on this question. The mark scheme also allowed some credit for descriptions which, although they may not have satisfied the given brief entirely, contained aspects of good practice in thermal energy experiments.

The best responses showed a logical approach, structured as suggested by the question, with concise sentences which communicated ideas well. Candidates can often miss straightforward points if planning is not approached in a sequential way.

The correct required apparatus was often identified, sometimes within the body of the instructions if missing from a list at the start. A stop-watch or other timing device was the most common omission. The use of different sized beakers was the usual means of obtaining containers of different surface areas and it was recognised by many that a range of at least 5 distinct values would be needed to plot a graph. Some good responses mentioned the need for the containers to be similar or of the same material and a number included insulation to ensure that loss of thermal energy from the sides or bottom of the container was minimised. There were, however, references to the use of lids, which meant that credit for the method could not be awarded as it defeated the object of the experiment.

Instructions for carrying out the experiment were often clear but essential steps were sometimes taken for granted. Some candidates did not specify the use of hot water or that water temperature should be measured at given times, merely referring to 'take results'. It was sometimes assumed that the experiment should be repeated for different containers without being stated in the plan.

Precautions such as different containers having the same volume of hot water or the same initial water temperature were often seen. Constant room temperature was also a common correct answer. Care should be taken with these details. Heating water to the same temperature then pouring it into the container to be tested is not necessarily the same as 'constant initial hot water temperature', as thermal energy is lost on pouring.

Suggestions for graphs were generally acceptable, most showing temperature against time as a set of cooling curves. Some of the stronger candidates included the calculation of temperature change in a given period or the calculation of cooling rate. These were seen plotted against surface area.

It should be noted that analysis or explanation of possible results, which is generally based on theory is not required in this type of planning experiment.