PHYSICS

Paper 0625/12
Multiple Choice

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

General Comments

The best-answered questions were **1**, **3**, **5**, **6**, **10**, **16**, **23**, **28**, **36**, and **40**. No questions proved particularly difficult for the candidates as a whole, although the lower achieving candidates found some questions quite challenging. Able candidates scored very highly throughout.

Comments on Specific Questions

Question 2

This question tested understanding of a speed-time graph, and a significant proportion of candidates opted for **C**, not appreciating that the area under the graph in the first 100 s of the journey was only half of (20×100) m.

Question 4

All able candidates were successful in this question on mass and weight, but the lower achieving candidates ones did not take account of the fact that the metal blocks had identical dimensions, so would therefore also have the same volume; reading the whole question carefully should be advised.

Question 7

A very popular distractor here was option **C**. Although there is no resultant force acting on the rod, there is a resultant moment, and candidates need to check for both these to be zero to ensure equilibrium.

Question 8

The topic of this question was energy changes. The less able candidates were divided amongst all of the options indicating that many were guessing, although option **C** was rather more popular than other distractors; this started with gravitational potential energy changing into chemical energy.

Question 9

Although this question on work and power was generally well answered, a considerable number of candidates opted for **A**. As all four people did the same amount of work, all that was needed was to look for the shortest time taken.

Question 11

A substantial proportion of the candidates gave an incorrect answer to this question on the manometer. Most of these chose **A**, not taking into account the extra hydrostatic pressure of the liquid in the manometer.

Question 13

There are two likely reasons why the majority of the lower achieving candidates chose distractor **B**. Either they believed that reducing the volume of the trapped gas would decrease its density, or perhaps they thought that there must be opposite changes in each column.

Question 14

A very large proportion of the weaker candidates, and many of the more able too, selected an answer which suggested that as condensation and solidification takes place the temperature falls.

Question 17

'Heat energy always travels upwards' attracted a large proportion of candidates; they need to be aware that heat energy can travel in different directions through conduction or radiation.

Question 24

As is very often the case in questions on reflection of sound, many of the lower achieving candidates did not double the distance to 2000 m when calculating the speed.

Question 29

The main cause of incorrect answers was because of candidates not understanding the effect of cross-sectional area on resistance.

Question 32

This capacitor question caused many of the lower achieving candidates to resort to guessing, with all of the options proving popular.

Question 33

Many of the weaker candidates could position a fuse correctly, but opted to place a circuit-breaker in parallel with the appliance.

PHYSICS

Paper 0625/22

Core Theory

Key Messages

Many of the higher scoring candidates were able to demonstrate that they had been prepared well for questions that applied knowledge and understanding of physics in a variety of contexts. In order to improve the performance of lower scoring candidates, teachers should provide further opportunities for candidates to apply what has been learnt in a range of situations. Candidates also need to have covered all sections of the Core syllabus.

The layout of the question on the examination paper provides a clear indication of the types of responses expected by Examiners. Candidates should be reminded to read questions carefully, noting the marks allocated and the space available for responses. In a number of cases candidates provided unnecessarily long responses to short response questions. In some cases this resulted in no credit being awarded as candidates had included both correct and incorrect responses in the same answer. For questions that have one line and one mark allocated, a concise response, that may only be one word, is expected.

As has been stated in previous Examiner's Reports, candidates should be encouraged to set out and explain the stages in their working clearly when completing questions requiring calculations. Examiners will often be able to give partial credit to candidates who clearly show the stages in their working even if the final answer is incorrect. Candidates who give only the answer risk the loss of all the credit allocated to the question if their answer is incorrect.

General Comments

There were a small number of very high scoring candidates who may have benefitted from being prepared and entered for the Extended Theory paper. It is apparent that many teachers have a sound appreciation of the syllabus requirements, as demonstrated by the high proportion of candidates who were prepared well for the questions. Candidates were, in many cases, able to demonstrate their knowledge and understanding of key concepts. Some areas of the syllabus were better known than others; in particular, the questions on energy transfer, the electric motor and radioactivity proved to be challenging for all but the highest scoring candidates.

All but the lowest scoring candidates were able to use and apply standard equations, and a majority of candidates were also able to rearrange equations correctly to calculate an unknown quantity, for example, question **7(b)(ii)(1)** required candidates to use $V=IR$ to determine the current. However, in the subsequent part of this question many candidates neglected to apply the new information obtained and displayed a lack of depth of understanding that resulted in incorrect responses. Less confident candidates would benefit from further practice in applying equations in a variety of contexts so as to be better prepared for examination type questions.

In a small but significant number of cases, candidates left parts of a question unanswered suggesting that topics had not been covered well, or that candidates' knowledge and understanding was less than secure. There was very little evidence of candidates being unable to access questions as a result of poor literacy skills; the vast majority of candidates were able to express their ideas appropriately and received credit for correct responses. In only one or two cases were candidates' responses to parts of a question illegible and credit could not be given.

Examination papers were completed well by the vast majority of candidates, indicating that sufficient time had been allowed for the paper. Candidates should be reminded to check carefully all their responses. Errors such as failing to answer part of a question, checking that the appropriate number of ticks had been used in a tick box question or the omission of a unit would then be avoided.

Comments on Specific Questions

Question 1

(a) There were many correct responses. In many of the responses where credit was not given, candidates confused force and energy.

(b) This question was not answered well by candidates. A common misconception was that acceleration increases with distance of fall, leading to the incorrect response that acceleration was greater at Y than at X.

(c) There were many correct responses that resulted in full credit.

(d) This part was answered well by only the highest scoring candidates. Incorrect responses included vague statements about speed and/or time.

Question 2

(a) This was answered well by better prepared candidates. In some cases a lack of care resulted in inaccurate marking on the diagram that prevented full credit from being given.

(b) A number of lower scoring candidates omitted to make a response to this question.

(c) A correct response was given by nearly all candidates. When incorrect, the response commonly given was "kg".

Question 3

(a) Many candidates gained credit for three of the four marking points available for this question, and many of the higher scoring candidates gained full credit. The mark that was often not awarded was for the chemical to electrical change.

(b) This question was found to be challenging by nearly all candidates. There were a number of candidates who did not give responses to either part of this question.

Question 4

(a) There were many correct responses.

(b) A correct response was usually stated.

(c) A high proportion of the candidates who responded to this question were able to gain full credit for their ray diagram.

(d) This question was answered correctly by very few candidates. Some incorrect responses included vague answers about density or speed, and other incorrect responses indicated that refraction took place at different points on the ray diagram.

Question 5

(a) (i) Full credit was generally awarded.

(ii) This was answered correctly very rarely. Many candidates labelled critical angles in each of the three diagrams.

(b) (i) Many candidates were credited for at least two of the three marking points for this question. Those that obtained partial credit normally showed an incorrect angle of refraction. The final marking point was generally scored by middle and higher scoring candidates.

(ii) A common incorrect response was diffraction.

Question 6

(a) There were many correct responses.

(b) This part was well answered by only the better prepared candidates.

(c) (i) A correct response was usually stated.

(ii) Many candidates obtained credit for at least two of the marking points and the better prepared candidates were able to gain full credit for their answers to this question. The common error was not appreciating that the distance is doubled or time is halved.

Question 7

(a) There were many correct responses. Common misconceptions were that a voltmeter measures current or charge.

(b) (i) There were many correct responses to the first part of the question.

(ii) 1. A correct response was usually given for the combined resistance.

2. Many candidates gained full credit for the calculation. Those that scored three of the four marking points available, invariably lost credit due to an incorrect or missing unit.

(iii) This question was not answered well, a common incorrect response being to multiply current by the combined resistance rather than the resistance of a single resistor.

(c) Creditworthy responses were generally given by only the higher scoring candidates.

Question 8

(a) This was answered well by the better prepared candidates. A common error was to include the buckling of railways as a useful example of expansion.

(b) Many middle and higher scoring candidates gained credit for at least one of their responses to this question.

(c) (i) This was not very well answered.

(ii) The better prepared candidates were normally able to gain credit for at least two of the marking points available for this question. A small number of candidates produced responses that gained full credit.

Question 9

(a) This question was not well answered. There were very many vague responses that described components of the motor without mentioning how the motor was able to turn.

(b) Many middle and higher scoring candidates gave creditworthy responses. However, the vague responses such as “use larger magnets” that were often given by candidates were not given any credit.

Question 10

(a) There were many correct responses.

(b) (i) A correct response was usually stated.

(ii) Fewer candidates answered correctly, with many vague answers often referring to the charge on the sphere.

(c) The majority of candidates gave a correct response.

Question 11

(a) Many candidates were able to obtain credit for the first marking point for stating that the count rate was decreasing, but did not mention that the decrease was at a decreasing rate.

(b) Only the higher scoring candidates gained credit.

(c) A small but significant number of candidates did not make a response to this question. There were very few correct responses.

(d) Very few candidates gave creditworthy responses.

Question 12

(a) There were many good responses that resulted in full credit.

(b) There were many correct responses.

(c) This question was generally well answered by all candidates.

PHYSICS

Paper 0625/32

Extended Theory

Key Messages

It is vital that candidates read questions from beginning to end very carefully. It is sometimes apparent that only a part of a question has been properly read, and candidates have made the assumption that the question being asked is a repeat of one they have encountered on a past paper. The answer they then write is inappropriate in part or in whole to the question in hand. This issue will be addressed in comments on particular questions on this paper.

Credit is not awarded for numerical answers where a wrong unit is given or the unit is omitted. Sometimes these errors or omissions occur because a candidate does not know the correct unit. However, there are not infrequent examples of candidates, not necessarily weaker ones, omitting units several times throughout the paper. In some of these cases the required unit is almost certainly known. The mark penalties incurred then have a serious effect on the overall mark for the paper.

General Comments

The vast majority of candidates deserve praise for the level of their performance. The impression gained in looking at scripts across the range of abilities was that candidates had demonstrated their strengths to the maximum possible extent. It was particularly encouraging that so few questions were left unanswered. Some very high marks were awarded. Candidates showing this level of achievement clearly absorb factual material extremely well and are also able to apply their knowledge to new and unfamiliar situations. These candidates showed themselves to be very adept at conveying their thoughts with succinct wording and economical layout in calculations. The middle range of candidates also showed many strengths, but found it harder to convey their thinking and to apply their knowledge of recalled facts, definitions and formulae. A small minority of candidates sitting this paper had significant difficulty in recalling facts and writing coherent answers. These candidates might have benefitted from being prepared and entered for the Core Theory paper.

Comments on Specific Questions

Question 1

(a) (i) In spite of the requirement to state the formula used, a number of candidates did not fulfil this demand. These candidates, and others who gave an inappropriate formula, gained no credit.

(ii) The majority of candidates correctly drew a straight-line for graph X from the origin to the point (3.2,32). Most of those who did not gain the credit continued their straight line beyond the required point.

(iii) Most candidates were awarded full credit for calculating the correct height. Some whose final answer was incorrect earned a compensation mark for writing down 'area under the graph' or an appropriate formula for this. A significant number simply multiplied 3.2 by 32.

(b) (i) Many candidates knew that air resistance increases as a stone falls, but a significant number answered that it decreases or is constant.

(ii) This question proved very testing for candidates, and many of the candidates had difficulty in gaining any of the available credit. Many candidates drew a straight line through the origin of lower gradient than graph X but terminating at 3.2 s. These candidates had simply assumed a smaller but constant acceleration and were consequently awarded credit for only one of the possible marking points. Some candidates extended their straight-line graph beyond 3.2 s. They had realised that both stones fell through the same distance and hence gained credit for two of the marking points. Only those who had fully taken note of the effect of increasing air resistance drew a curve of decreasing gradient to beyond 3.2 s.

Question 2

(a) (i) Most candidates correctly multiplied the given mass by 10. The available credit was forfeited, however, by those who gave the weight in kg.

(ii) There were many correct calculations. The most common source of error was to subtract the mass rather than the weight from the given upward force acting on the rocket.

(iii) With any error from **(a)(ii)** carried forward and not again penalised, most candidates applied the formula $F = ma$ correctly.

(b) Most candidates could identify one of the possible reasons for the increased acceleration of the rocket.

Question 3

(a) Correct completion of the given statement depended on very careful reading of the sentence. The requirement was to identify two quantities of zero value, rather than two equal quantities, which was clearly the understanding of many. Only a minority of candidates wrote resultant, net or total force and resultant, net or total moment in the spaces.

(b) (i)1. Most answers correctly gave 288 N m, although in this case, exceptionally, the writing down of a wrong unit or no unit being given was condoned.

(i)2. Some candidates clearly did not appreciate what the question required of them.

(ii) The correct answer of 90 N was achieved by the majority, even by many who had given an incorrect response in **(b)(i)2**.

(iii) Answers suggesting in an acceptable way that an upward force was required for equilibrium were accepted. Some answers were too vague or confused to be rewarded.

Question 4

(a) Except for a wrong type of energy being quoted by some candidates in **(a)(i)**, in the succeeding parts of **(a)** a very large proportion of the answers seen were totally correct.

(b) A good proportion of the candidates could refer to the small temperature rise as the factor leading to the need for high sensitivity. Others had considerable doubt about the meaning of sensitivity.

Question 5

(a) In **(i)**, there seemed to be good knowledge about the use of X-rays, but in **(ii)** there was less certainty and fairly frequent reference to other parts of the spectrum than infra-red.

(b) (i) The formula $v = f\lambda$ was in general identified, but sometimes wrongly transposed thereby sacrificing possible further credit. Most candidates calculated the wavelength correctly, but a few gave the unit as λ.

(ii) This two-stage calculation produced a commendable number of correct final answers. For those who did not achieve this, the quantity of energy needed was usually calculated correctly, but the correct use of the 65% factor caused some difficulty, sometimes being used to find a fraction of the energy rather than the power.

Question 6

(a) Mistakes in dealing with the path of the ray through the glass block were infrequent. Most errors, if made, concerned the labelling of two correct equal angles.

(b) In both **(i)** and **(ii)**, the majority of candidates could quote the correct formulae and could usually use it to calculate the correct answers.

(c) The correct term 'dispersion' was quoted by many of the candidates. It was apparent that the low achieving candidates were as likely to know the correct term as the stronger ones.

Question 7

(a) (i) Only a very small proportion of the candidates knew, as required by the syllabus, what is meant by an electric field.

(ii) Most candidates had a general idea of the form of the radial field set up by the charged sphere. Credit was sometimes not awarded due to inaccurate spacing of the lines they drew or for pointing the arrows on the lines in the wrong direction.

(b) Some candidates could only be awarded credit for a single marking point, either for correctly choosing the positively charged rod or for choosing the wrong rod but placing it close to the sphere.

Many candidates who achieved credit for only two of the marking points had not addressed in their answer the issue of the sphere being given a uniform charge. It is possible that some of these candidates had not read the question with sufficient care. Those awarded full credit had provided all the necessary details.

Question 8

(a) (i) Almost all the candidates correctly identified the component as a diode.

(ii)1. The idea of how components in series share the available p.d. is not well understood by many candidates. Many of the candidates gave the p.d. across the diode as 12 V or 11.3 V.

(ii)2. Because the p.d. across the 4.0 Ω was given as 11.3 V in the question, a good majority of candidates were able to calculate the current through this resistor. Those who had not taken note of the 11.3 V used 12 V instead and could only gain partial credit for stating the correct formula.

(b) (i)1. Most candidates calculated the current in the 8.0 Ω resistor correctly.

(i)2. Only a small proportion of answers showed the current through the battery as the addition of the two previous answers. There is clearly poor understanding of the division of the main circuit current in parallel resistors.

(ii) Various wrong currents were given as answers including zero, the answer to **(b)(ii)2** repeated, and others. Only a minority of candidates realised that the diode branch of the parallel arrangement no longer conducted and worked out the correct answer of 1.5 A.

Question 9

In both **(a)** and **(b)**, a high percentage of candidates could be awarded full credit.

(c) The majority of candidates successfully addressed the idea of the cutting of magnetic lines of force by the rotating coil. This gained credit for the first marking point. Rather fewer candidates went on to say that electromagnetic induction took place, or that the current in the coil was induced or that an induced voltage caused the current. Since candidates had to explain why there was a current, the idea of induction had to be explicitly stated for full credit to be awarded.

Question 10

(a) (i) In general, candidates had little difficulty in stating the purpose of the heater in **1** or in identifying the cathode and anode respectively in **2** and **3**.

(ii) It was expected that candidates would approach this question by explaining what would happen to the cathode rays if the space inside the tube were not a vacuum. However, some candidates did not take this approach. Their answers tended to miss the point about the electrons in the cathode ray beam being deflected from their path, or stopped, by their collisions with molecules or particles. A large number of candidates did, however, offer acceptable explanations.

(b) (i) Any reference to the Y-plates, made by a significant number of candidates, gained some credit. Rather fewer of those candidates could be awarded further credit, however, for stating that an alternating voltage needed to be applied to those plates.

(ii) In this case the credit was awarded to a majority of the candidates for any reference to the X-plates.

(iii) Straightforward answers such as ‘reduce the Y-plate voltage’ would have sufficed, and this type of answer was offered by many. Other candidates however frequently suggested changes to, for example, the time-base or the cathode voltage or the plates, for no credit.

Question 11

(a) Most candidates could be awarded the credit. Some unacceptable answers referred to the charge on only one of the particles.

(b) The success rate at drawing the paths of the three particles was high. Misinterpretation of the information about the particles, possibly due to recall of a learned diagram rather than reading the question carefully, may have been the cause of some candidates reversing the continuation of the paths of particles A and C, thus only gaining credit for one of the three marking points.

(c) Those totally aware of the conclusions of the experiment made two relevant points about the nuclei of the gold atoms or the empty spaces surrounding them and gained full credit. Less aware candidates made only one relevant point. The remainder referred only to atoms, not nuclei, in their answers or simply described what was happening to the particles A, B and C.

PHYSICS

Paper 0625/52

Practical

Key Messages

To achieve well in this examination, candidates need to have a thorough grounding in practical work during the course. Candidates should have as much personal experience of carrying out experiments themselves as possible. The practical work should include reflection and discussion of the significance of results, precautions taken to improve reliability and control of variables.

Centres are provided with a list of required apparatus well in advance of the examination date. Where Centres wish to substitute apparatus, it is essential to contact Cambridge to check that the change is appropriate and that candidates will not be disadvantaged. Any changes must be recorded in the Supervisor's report so that suitable allowance may be made for them when marking candidates' scripts.

Candidates should be advised to read the questions through very carefully to ensure that they are answering the question as written, and not simply recalling the answer to a different question.

Where justification or explanation of a response is asked for, candidates should be prepared to answer using values from their own results or from data given in the question, rather than from theoretical knowledge.

General Comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques. These include:

- handling practical apparatus and making accurate measurements
- tabulating readings
- graph plotting and interpretation
- manipulating data to obtain results
- drawing conclusions
- understanding the concepts of results being equal within the limits of experimental accuracy
- dealing with possible sources of inaccuracy
- control of variables
- choosing the most effective way to use the equipment provided.

The majority of candidates entering this paper were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of each practical test were attempted and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly, record observations clearly and perform calculations accurately and correctly. Units were well known and were generally included, writing was neat and legible and ideas were expressed logically. The gathering and recording of data presented few problems for most candidates. However many candidates seemed less able to derive conclusions backed up by evidence, or to present well thought out explanations.

The particular questions which proved more difficult for candidates varied significantly from Centre to Centre, perhaps suggesting that a full range of experience with different types of experiment had not been available. In **Questions 1** and **4** only the more able candidates were able to produce clear explanations and justify conclusions adequately.

The ability to record readings to an appropriate precision, usually reflecting the measuring instrument being used, or to quote a derived result to an appropriate number of significant places, still causes difficulty for many candidates. There were also many examples of instances where a candidate had repeated a measurement and had overwritten their first answer. This often made it difficult for the Examiner to see what the reading was, and sometimes the Examiner was unable to award the mark. Candidates should be encouraged to cross out completely and to re-write their answers so that there is no ambiguity. Some candidates still find difficulty in drawing a best-fit line to display their data.

There were instances this year of Centres disadvantaging their candidates by not supplying the correct apparatus. Where this was not mentioned in the report from the Supervisor, it was difficult to award credit. It is important to provide details of changes made to the specified apparatus, and possibly specimen results if appropriate, so that Examiners can give full credit to candidates' results which lie outside the expected tolerance values. Cambridge should agree major changes to apparatus in advance of the examination date.

Comments on Specific Questions

Question 1

(a) Most candidates correctly drew the voltmeter in parallel with the lamp.

(b) Many recorded the potential differences and currents correctly although some inconsistency in precision was seen. It is expected that all potential differences will be recorded to at least one decimal place and all currents to at least two decimal places.

The majority of responses showed a decrease in both of these values as l decreased, indicating that the experiment had been carried out correctly.

(c) Many candidates correctly calculated the resistances and recorded them to two or three significant figures. Only a small minority showed excessive significant figures but there were a few rounding errors.

(d) Many stated the link between brightness and resistance although fewer used results from the table to explain their reasoning. A number attempted to explain the link from theory, forgetting the practical nature of this examination and the need to use data from the question in support of their statement.

A significant minority of candidates seemed to have misread the question and stated the link between the length of the resistance wire and the current in the lamp.

Credit was given to those candidates who had obtained a reversed pattern in the change of the lamp's resistance with l and used this to suggest a link opposite to that expected.

(e) A correct reference to the use of a variable resistor in series with the lamp was seen in many responses. The alternative of a potential divider or potentiometer replacing the slide wire was acceptable. A number of candidates lost some credit for an incorrect symbol or showing the variable resistor in parallel with the lamp. Circuits with a thermistor (often shown as the symbol for a variable resistor) or light dependent resistor were not accepted.

Very few candidates recognised the need to increase the supply voltage in order to make the lamp glow more brightly.

Question 2

(a) Many candidates obtained a suitable value for v_1, showing careful experimental technique. However, candidates should be aware that recording of measurements using a ruler will generally be expected to the nearest 0.1 cm. Where Centres had clearly provided lenses of a different focal length from that asked for in the Confidential Instructions, credit was given for a matching value of v_1.

(b) Many calculated the focal length correctly and included the unit.

(c) Good experimental technique was reflected in many answers to this question. In a minority of responses, it seemed that the value of u_2 had been altered on reading the suggestion in part **(e)**, sometimes creating difficulties for subsequent calculation. This practice must be avoided; the Examiners do expect that there will be differences in candidate's results due to usual experimental uncertainties.

(d) In many cases, there was good correlation between this value for the focal length and that calculated in part **(b)**.

(e) A number of candidates were able to write convincingly using the concept of 'within the limits of experimental accuracy'. Others, however, merely stated that the values were 'different' and incorrectly deduced that their results did not support the suggestion.

Where there was a significant difference between the values, perhaps due to an incorrect procedure, the opposite statement was accepted. However, in these cases, most candidates did not use the justification that the values were 'outside the limits of experimental accuracy', again simply stating that they were 'different'. This, alone, is not an acceptable explanation.

(f) Many candidates were able to gain full credit for this question, a large number of these commenting on the need for a darkened room or the shielding of the image from extraneous light. A few gave precautions which were not particular to 'this experiment' as asked in the question, such as ensuring that measurements were done properly or taking care to follow instructions.

Question 3

(a) Most candidates recorded values of *a* and *b* that were within a close range of the expected sum of 45.0 cm. However, whole numbers of centimetres were sometimes not recorded to at least one decimal place, despite the clear indication in the question of the 95.0 cm and 50.0 cm marks.

(b) Most calculated the *S* values correctly although there were some rounding errors and a number of candidates expressed results incorrectly to one significant figure.

(c) This was a fairly straightforward graph and some good skills were in evidence. Variations between Centres, however, suggested that some lacked experience in these techniques.

Axis labels were correct in the large majority of responses. A very few candidates reversed the axes or gave a unit to *S*. A ratio should have no unit attached.

Choice of scale was usually good and plotting was generally of a high standard with many candidates using small crosses instead of dots, which are sometimes obliterated by the line. Some lost credit due to dots that were too large so that the accuracy of the plotting could not be judged.

The very small minority of candidates who chose difficult scales, based on intervals of 3 or 15, had a higher chance of incorrect plotting.

Many were able to judge a good line of best fit but a number joined points together or produced thick lines. Some misjudged the line by forcing it through the origin rather than following the trend of their plots.

It is expected that all points will be taken into account when deciding on the placement of a best-fit line, but if, through incorrect plotting, a point is clearly inconsistent with the general trend, it should be marked as an anomaly and ignored. However, there were instances of points very close to the general trend being marked as anomalies so that they could be ignored. Credit was not given in these cases.

(d) There was a variation in how candidates showed their method of finding the gradient. A triangle was clearest and was the most common. Use of marks on the axes or line is acceptable in some cases but is not often easy to interpret and should be avoided.

A small but significant number of candidates incorrectly drew their triangle from plotted points rather than from their graph line.

It was clear that some candidates were not able to use the triangle correctly to obtain the gradient.

An answer for M_R, correctly calculated from the candidate's value of *G* and expressed to two or three significant figures was seen in many cases.

(e) Some candidates answered this question very well, being completely clear in their explanations. However, many produced confusing or incomplete answers, suggesting that they had not taken note of the apparatus provided.

The need for the metre rule to balance when the 50.0 cm mark was placed above the pivot, the mass having been removed, was not always stated.

Question 4

(a) Most candidates recorded temperature readings clearly with the majority giving correct °C units. A few omitted the 0 s value in the *t* column while a small number left the units blank, possibly from not reading the question carefully. Candidates should be aware that it is not good practice to attach units to each value throughout the table. The possibility of units being contradicted or written incorrectly is increased significantly and, in that case, would be penalised.

θ values generally decreased steadily although a small number of candidates recorded room temperature in the first row of the table rather than the initial temperature of the hot water.

(b) In most cases, the temperature of the water in test-tube **B** fell less quickly than that in test-tube **A**.

Often, the starting temperature of the water was not the same as in test-tube **A**, despite reference to this in part **(d)**. This may very well have affected the comparative temperature change for some candidates.

(c) A large number of candidates arrived at a correct conclusion from the fact that the water cooled more quickly in one test-tube, giving the comparative change in temperature over 180 s as evidence. Fewer pointed out that the changes took place in the same period of time, which gained the second marking point. Some candidates lost credit by making reference only to there being a lower final temperature; this was insufficient evidence of a difference in the rate of cooling except where it was recognised that initial temperatures were equal.

Answers based entirely on theoretical considerations were given no credit.

(d) This question required reference to precautions needed for reading temperatures reliably. Few were able to give convincing responses and many referred to general precautions for thermal experiments and did not address temperature measurement at all. Candidates should be aware of the need to read questions carefully so that answers are focused on specific requirements.

A number of candidates referred to parallax but did not explain how it might be avoided.

(e) More candidates gained full credit for this question although many had already used suitable answers mistakenly in part **(d)** and produced incorrect alternatives here.

A significant number gave more than the required two suggestions and lost credit when the extra responses were incorrect and negated correct answers.

PHYSICS

Paper 0625/62
Alternative to Practical

Key Messages

To achieve well in this examination candidates need to have a thorough grounding in practical work during the course. Candidates should have as much personal experience of carrying out experiments themselves as possible. The practical work should include reflection and discussion of the significance of results, precautions taken to improve reliability and control of variables.

Candidates should be advised to read the questions through very carefully to ensure that they are answering the question as written, and not simply recalling the answer to a different question.

Where justification or explanation of a response is asked for, candidates should be prepared to answer using values from their own results or from data given in the question, rather than from theoretical knowledge.

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- dealing with possible sources of inaccuracy
- control of variables
- choosing the most effective way to use the equipment provided.

Most candidates were well prepared and seemed to have a good range of personal practical experience on which they could draw in their responses to questions. Where candidates appeared not to have this breadth of experience, responses to questions asking for practical details were not so successful. This was clear in questions such as **1(a)** and **4(c)**.

No parts of any question proved to be inaccessible to candidates and there was little evidence of candidates running short of time.

The majority of candidates were able to follow instructions correctly, record measurements clearly and perform calculations accurately and correctly. Units were well known and were often included, writing was legible and ideas were expressed logically. However, candidates' ability to derive conclusions from given experimental data and to justify them was less well shown. This was most apparent in **Questions 2(b)** and **3(d)**.

All questions provided opportunities for differentiation and particularly good were **Questions 2(c)**, **3(e)** and **5(b)**, where the explanations and suggestions allowed the better candidates to demonstrate their ability.

The vast majority of candidates finished the paper and there were few scripts with substantial numbers of questions left unanswered. There were some scripts which showed an exemplary understanding of practical skills, but there were also those which demonstrated a lack of graph skills, poor understanding of significant figures and a lack of comprehension of good practice in carrying out experiments.

Comments on Specific Questions

Question 1

(a) Many candidates were unable to think this through clearly enough to gain the mark. The need to provide some reference point for the 95.0 cm graduation which would be obscured by the mass was not understood. Those who were successful showed that they had experience of this type of experiment, the majority of these indicating the requirement for the mass to occupy an equal number of graduations on either side of the 95.0 cm mark.

(b) Most calculated the *S* values correctly although there were some rounding errors, particularly with the first value, and a number expressed results incorrectly to one significant figure.

(c) This was a fairly straightforward graph and some good skills were in evidence.

Axis labels were correct in the large majority of responses. A very few candidates reversed the axes or gave a unit to *S*. A ratio should have no unit attached.

Choice of scale was usually good and plotting was generally of a high standard with many candidates using small crosses instead of dots, which are sometimes obliterated by the line. A minority lost a mark due to dots that were too large.

The very small minority of candidates who chose difficult scales, based on intervals of 3 or 15, had a higher chance of incorrect plotting.

Many were able to judge a good line of best fit and only a very small number joined points together or produced thick lines. Some misjudged the line by forcing it through the origin rather than following the trend of their plots.

It is expected that all points will be taken into account when deciding on the placement of a best-fit line, but if, through incorrect plotting, a point is clearly inconsistent with the general trend, it should be marked as an anomaly and ignored.

(d) There was a variation in how candidates showed their method of finding the gradient. A triangle was clearest and was the most common. Use of marks on the axes or line is acceptable in some cases but is not often easy to interpret and should be avoided.

A small but significant number of candidates incorrectly drew their triangle from plotted points rather than from their graph line.

It was clear that some candidates were not able to use the triangle correctly to obtain the gradient and this was reflected in the value for the mass of the metre rule. An answer within the expected range was, however, seen in many cases.

(e) Some candidates answered this question very well, being completely clear in their explanations. However, many produced confusing or incomplete answers, suggesting a lack of personal experience with this apparatus.

The need for the metre rule to balance when the 50.0 cm mark was placed above the pivot, the mass having been removed, was not always stated.

Question 2

(a) Most recorded the units correctly and entered suitable times, including the 0 value.

A few left these blank, possibly through not having read the question carefully.

(b) A large number of candidates arrived at a correct conclusion from the fact that the water cooled more quickly in test-tube **A**, giving the comparative change in temperature over 180 s as evidence. Fewer pointed out that the changes took place in the same time period, which gained the second marking point. The lower final temperature in test-tube **A** was not acceptable evidence on its own, as the starting temperatures were different. A minority gave theoretical answers and did not score.

(c) This question required reference to precautions needed for reading temperatures reliably. Few were able to give convincing responses and many referred to general precautions for thermal experiments and did not address temperature measurement at all. Candidates should be aware of the need to read questions carefully so that answers are focused on specific requirements.

A number of candidates referred to parallax but did not explain how it might be avoided.

(d) More candidates gained full credit in this question although many had already used suitable answers mistakenly in part **(c)** and produced incorrect alternatives here.

A significant number gave more than the required two suggestions and lost credit when the extra responses were incorrect and negated correct answers.

Question 3

(a) Most candidates correctly drew the voltmeter in parallel with the lamp.

(b) The correct 1.5 V reading on the voltmeter with a full scale deflection of 5 V was seen in the majority of cases. A few candidates were a little careless in drawing the arrow and missed the precise 1.5 V mark on the scale, gaining credit only for the correct voltmeter.

(c) Many candidates correctly calculated the resistances and recorded them to two or three significant figures. Only a small minority showed excessive significant figures but there were a few rounding errors, particularly on the 7.9 Ω value which was occasionally shown as 7.8 Ω.

(d) Many stated the link between brightness and resistance although fewer used results from the table to explain their reasoning. A number attempted to explain the link from theory, forgetting the practical nature of this examination and the need to use data from the question in support of their statement.

(e) A correct reference to the use of a variable resistor in series with the lamp was seen in many responses. The alternative of a potential divider or potentiometer replacing the slide wire was acceptable. A number of candidates lost marks for an incorrect symbol or showing the variable resistor in parallel with the lamp. Circuits with a thermistor (often shown as the symbol for a variable resistor) or light dependent resistor were not accepted.

Only a small minority of candidates recognised the need to increase the supply voltage in order to make the lamp glow more brightly.

Question 4

(a) Very few candidates gave the value of u_1 as 5.0 cm, most gaining credit only for a correct v_1. Candidates should be aware that recording of measurements using a ruler will generally be expected to the nearest 0.1 cm.

Many calculated the focal length correctly and included the unit.

(b) A correct value for u_2 was generally seen and some candidates were able to write convincingly using the concept of ‘within the limits of experimental accuracy’. Others, however, merely stated that the values were ‘different’ and incorrectly deduced that the results did not support the suggestion.

(c) Many candidates were able to gain full credit for this question, a large number of these commenting on the need for a darkened room or the shielding of the image from extraneous light. A few gave precautions which were not particular to ‘this type of experiment’ as asked in the question, such as ensuring that measurements were done properly or taking care to follow instructions.

Some stated precautions for an optical experiment involving pins, showing a learning of previous mark schemes rather than careful consideration of the question.

Question 5

(a) The great majority of candidates recorded both temperatures correctly.

(b) Here, some candidates answered well, giving clear reasoning and suggesting appropriate steps to overcome the problems they had identified.

(i) Most successful candidates suggested that the iron block had not been allowed sufficient time to attain the temperature of the water or that thermal energy was lost to the surroundings on transfer, giving suitable improvements to these aspects of the procedure.

(ii) In this case, loss of thermal energy once the block was in the cold water needed to be considered. The most common reasons given included evaporation from the water surface or loss to the surroundings from the walls of the beaker. Provision of a lid and insulation of the beaker were the usual solutions proposed.

Many candidates seemed unable to think clearly about the procedure and did not target their answers appropriately. A significant number gave the right answers in the wrong places, many citing loss of thermal energy on transfer as a reason in part **(ii)**. Perhaps this was due to not having read the question carefully or a lack of familiarity with this type of experiment.