PHYSICS

Paper 0625/11
Multiple Choice

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

General comments

The best answered **Questions** were **4**, **8**, **9**, **11** and **25**, with **Question 34** proving the most difficult.

Comments on Specific Questions

Question 3

This question involved calculating distance travelled from the area under a speed/time graph. A significant number of candidates forgot to halve the product of final speed and time.

Question 7

The topic here was extension/load graphs. Many candidates did not realise the significance of the graph starting at the origin, meaning that the vertical axis represented extension rather than measured length.

Question 12

A significant number of candidates gave answers which implied that the pressure of the air in the pump could increase at constant temperature without its volume decreasing.

Question 13

This question tested understanding of the process of evaporation, and it was generally well answered. However, the popularity of distractor C showed that, although there was awareness that the remaining liquid would cool, the link between this and the lowering of the average energy of its molecules was less widely known.

Question 18

A significant number of candidates chose option D, which showed a mirror facing towards scout Q. This would not be suitable as it would not reflect the ray in the required direction.

Question 20

Most candidates knew the correct order for the electromagnetic spectrum, although a significant proportion chose D, which showed the electromagnetic radiations in order of *decreasing* frequency.

Question 23

Most responses were correct to this question on sound and hearing, but many candidates opted for C, frequency too high. Candidates should know that the amplitude of a sound wave must also be large enough for the sound to be heard.

Question 26

Although the majority of candidates answered this question correctly, a significant minority seemed unaware of this standard method of demagnetisation.

Question 31

Although there were many correct answers to this potential divider question, there was also a large number of candidates who appeared to be guessing, with all of the distractors being popular.

Question 34

Although this question was simple recall, it was not well answered. Option C, the field around a straight wire, was the most popular answer.

PHYSICS

Paper 0625/12
Multiple Choice

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

General comments

Candidates found **Questions 1**, **3**, **4**, **5**, **11**, **13**, **20**, **22** and **28** the easiest. Only **Question 14** caused a problem for a significant number of them.

Comments on Specific Questions

Question 6

The topic for this question was moments, and distractor B proved popular. This showed two forces acting on the same side of the bar, but in the key (A) the second force was further from the pivot than it was in option B. Many candidates had not appreciated that two forces can act in opposite directions but still produce a turning effect in the same direction of rotation.

Question 7

The topic here was extension/load graphs. Many candidates did not realise the significance of the graph starting at the origin, meaning that the vertical axis represented extension rather than measured length.

Question 8

A significant number of candidates chose option D. Although the water gains kinetic energy in falling, the stem of the question refers to energy stored in a lake or reservoir, and this is gravitational.

Question 12

A significant number of candidates gave answers which implied that the pressure of the air in the pump could increase at constant temperature without its volume decreasing.

Question 14

The concept of thermometer fixed points was not well known, and the answers frequently followed the misconception that these were the highest and lowest temperatures shown on the thermometer scale, leading to the incorrect choice of option D.

Question 19

A significant number of candidates chose option D, which showed a mirror facing towards scout Q. This would not be suitable as it would not reflect the ray in the required direction.

Question 27

Although the majority of candidates answered this question correctly, a significant minority seemed unaware of this standard method of demagnetisation.

Question 31

Many candidates coped well with this question on lamps in parallel, although a popular distractor was option B, corresponding to the common misconception that adding lamps to a parallel circuit will produce a significant reduction in brightness. Candidates need to take very careful note of the word '**not**' when it occurs in a question.

PHYSICS

Paper 0625/13
Multiple Choice

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

General comments

Questions 1, **8**, **9**, **11** and **32** were the best answered on this paper, and only **Question 35** caused widespread difficulty.

Comments on Specific Questions

Question 2

This question involved calculating distance travelled from the area under a speed/time graph. A significant number of candidates forgot to halve the product of final speed and time.

Question 5

The topic here was extension/load graphs. Many candidates did not realise the significance of the graph starting at the origin, meaning that the vertical axis represented extension rather than measured length.

Question 16

This question tested understanding of the process of evaporation, and it was generally well answered. However, the popularity of distractor C showed that, although there was awareness that the remaining liquid would cool, the link between this and the lowering of the average energy of its molecules was less widely known.

Question 17

A significant number of candidates gave answers which implied that the pressure of the air in the pump could increase at constant temperature without its volume decreasing.

Question 18

Most responses were correct to this question on sound and hearing, but many candidates opted for C, frequency too high. Candidates should know that the amplitude of a sound wave must also be large enough for the sound to be heard.

Question 20

Most candidates knew the correct order for the electromagnetic spectrum, although a significant proportion chose D, which showed the electromagnetic radiations in order of *decreasing* frequency.

Question 22

A significant number of candidates chose option D, which showed a mirror facing towards scout Q. This would not be suitable as it would not reflect the ray in the required direction.

Question 31

Most responses were correct to this question on fuses. Some candidates realised that the fuse should be in series with the appliance, but did not know that it should be on the live side.

Question 33

Although the majority of candidates answered this question correctly, a significant minority seemed unaware of this standard method of demagnetisation.

Question 35

Although this question was simple recall, it was not well answered. Option C, the field around a straight wire, was the most popular answer.

PHYSICS

Paper 0625/21

Core Theory

Key Messages

Apart from the basic requirement to learn information from right across the Core syllabus, there were three further aspects in which candidates could have been more careful and so improved their performance.

Candidates must read questions carefully and take note of the available space and marks allocated, as this information provides a clear indication of the type of response that the Examiner is seeking. In a number of cases candidates only provided the briefest of responses to a question where more detail was required.

In questions requiring the calculation of a quantity, candidates must set out and explain their methods clearly. Candidates who give only an answer risk the loss of all marks allocated to the question if their answer is incorrect. Those who clearly show the stages in their working will often obtain credit for parts of their response even if the final answer is incorrect.

All candidates would be well advised to check through their responses. Errors such as omitting to answer part of a question, not including a unit, or entering an inappropriate number of ticks in the option boxes, might then be avoided.

General Comments

Many candidates were able to demonstrate a breadth of knowledge across all sections of the Core syllabus. Questions from some areas of the syllabus were well answered by all candidates, however the questions on radioactivity proved to be challenging for all but the most able. A small number of the higher scoring candidates may have benefitted from being prepared and entered for the Extended Theory paper.

It is clear that candidates have been well prepared for certain calculations, for example, the use of the transformer equation that was well answered by all but the very weakest candidates. However, a number of candidates found difficulty in applying standard equations to new situations which resulted in incorrect calculations being undertaken.

A significant number of candidates left parts of a question blank suggesting that their knowledge and understanding was less than secure. Such candidates would benefit from further opportunities to practice answering examination type questions and in particular questions that require candidates to apply their knowledge and understanding to new situations.

There were few cases of candidates being unable to express themselves adequately. A very small number of scripts had some responses which were illegible.

There was no evidence to indicate that candidates had insufficient time to complete the paper.

Comments on specific questions

Question 1

(a) Many candidates were aware of the need to divide distance by time, but few used the correct values. A common error was omitting to take account of the original plant height.

(b) (i) The majority gained full credit for their responses, but a significant number lacked precision, plotting points in the wrong square or on the wrong day.

(ii) A large proportion of candidates recognised that the points were not on a straight line. Some candidates incorrectly drew on information from the table rather than the points on the graph.

Question 2

(a) This question was answered well by the better candidates. Common mistakes included the use of the term "extends" to explain extension, and responses that indicated the extension was the total length of the spring when a load had been added.

(b) (i) Many candidates gained full credit.

(ii) This question was not well answered. The most common errors were in rearranging the equation $W = mg$ and the lack of an appropriate unit. The information 'Take the weight of 1 kg to be 10 N' is given on the front of the Question Paper.

Question 3

(a) This question was well answered by those candidates that had had experience of observing Brownian motion.

(b) Fewer candidates than expected were able to represent the random movement of a smoke particle and gain full credit. A common incorrect response was to draw a number of atoms representing a gas rather than on smoke particle.

(c) A good number of candidates gained full credit for indicating collisions between air molecules and smoke particles.

(d) There were many good answers from middle and higher ability candidates although in some misspelling prevented credit from being given.

Question 4

(a) A correct response was usually stated.

(b) Many candidates scored three of the available marking points, identifying the use of planks or a ladder to increase surface area and reduce pressure. Few candidates made use of pressure = force per unit area or the idea of spreading the load. In a small number of cases, candidates gave an incorrect response by referring to the use of skates.

Question 5

(a) The correct answer was stated by the majority of better prepared candidates, however, there were significant numbers who gave the temperature displayed by the thermometer.

(b) Candidates usually gained some credit for their responses but few gained full credit. Common misconceptions were that the ceiling was closer to the sun or 'heat rises' (rather than hot air). Very few responses included any mention of expansion.

(c) The majority of candidates gained some credit for a partial response to this question. A significant number of candidates did not include any mention of the thread withdrawing towards the bulb.

(d) A correct response was usually given.

Question 6

(a) (i) A significant number of candidates were unable to identify the angle of incidence and angle of reflection correctly.

(ii) The majority of candidates gave the correct answer to this question.

(iii) The majority gave a correct response in terms of the periscope being used in a submarine. In some cases there were responses that were unclear or suggested that the periscope was for seeing things far away or above the observer.

(b) (i) Very few candidates could be awarded credit for their response to this question. A common misconception was to identify the focal points rather than the focal lengths. A significant number indicated the distance between F_1 and F_2 without making clear that this was two focal lengths.

(ii) Few candidates appreciated that the ray had to go through the focal point. A greater proportion of candidates were aware that there would be refraction, however some responses were poorly represented and could not be given credit.

(iii) Only the better prepared candidates gained credit for their responses to this question.

Question 7

(a) A correct response was given by the majority of candidates.

(b) (i) Most candidates gave responses indicating no change to the reading.

(ii) A very large number of candidates incorrectly suggested that the pointer moved left or right.

(iii) Similarly to **Question (b)(ii)** above, many candidates incorrectly suggested movement of the pointer but in the opposite direction to that stated in **(b)(ii)**.

(iv) Many candidates recognised that the pointer would move but only the better candidates were able to gain full credit for appreciating that the pointer would deflect from side to side.

Question 8

(a) (i) The correct answer was usually stated. A significant number of candidates, however, attempted to calculate a value for the current.

(ii) A good proportion of the better prepared candidates gained full credit for their responses to this question. The most common errors were in rearranging the equation $V=IR$ and the omission of the unit.

(iii) Very few candidates correctly indicated that the current would be 0.6 A. Common misconceptions included 1.2 A and 0.3 A.

(b) (i) A good number of the able candidates gave correct responses to this question.

(ii) Circuit diagrams were usually well drawn and included a component in series with the lamp. The better candidates obtained full credit for including the accepted symbol for a variable resistor, a rectangle with a strike-through arrow.

Question 9

(a) Very few candidates correctly identified the standard test of repelling the N pole of known magnet. Most described attracting an S pole or gave vague answers in terms of the use of iron filings or a compass.

(b) Most candidates scored well on this question, the majority of candidates identifying the correct responses.

(c) (i) Most candidates gave a correct response to this question.

(ii) Many candidates gained credit for this question.

(iii) Many of those that gained credit in **(c)(ii)** went on to give an incorrect response to this question as they did not appreciate that the forces would be the same.

Question 10

(a) Many candidates gained credit for their response to this question. The most common incorrect responses were copper and steel.

(b) This calculation was done well, indicating that candidates of differing abilities had all been well prepared for a question of this type. Many of those who did not give a correct response omitted to show their working and so were unable to gain any credit.

Question 11

(a) Many candidates scored full credit, although weaker candidates gave responses in terms of the structure of an atom, stating neutrons, protons and electrons.

(b) A high proportion of candidates gained credit for at least two of the three marking points allocated to this question. A common misconception was the statement that gamma was the most easily absorbed radiation.

(c) Only the very best candidates scored well on this question. Candidates seemed to be unclear about half life and how this would affect the numbers of particles remaining and decaying.

Question 12

This question was answered well by all but the weakest of candidates.

PHYSICS

Paper 0625/22
Paper 2 Core

Key Messages

Apart from the basic requirement to learn information from right across the Core syllabus, there were three further aspects in which candidates could have been more careful and so have improved their performance.

In calculations, candidates must set out and explain their working correctly. When a candidate gives a wrong final answer and no working is shown, or the working is very unclear, it is often impossible for the Examiner to give any credit.

Greater care and accuracy is needed by some candidates when indicating distances on diagrams.

In order to improve their performance, candidates should practise applying their knowledge to new situations, for example by attempting questions in support materials or exam papers from previous sessions.

General Comments

A high proportion of candidates were well prepared for this paper. Equations were generally well known by most of the candidates, but a significant number struggled when required to rearrange the equations.

Often candidates had been well taught how to apply their knowledge and understanding to fairly standard situations. On occasions however, when asked to apply their knowledge to a new situation, they demonstrated some confusion and a lack of breadth of understanding. The more successful candidates were able to think through the possibilities and apply their knowledge when the question asked for suggestions to explain new situations.

The questions on thermal physics and the sound and waves topics were generally not well answered by candidates. There were a significant number of candidates who gave answers that were related to the topic being tested but did not answer the question, possibly because of not reading the question properly or recalling a learned response to a different question.

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

Comments on specific questions

Question 1

(a) A number of candidates were unsure of how to calculate a distance travelled from the speed/time graph. Very few started their answer with statements to the effect "distance travelled = area under graph"; this approach is very helpful and often enables candidates to gain some credit for the method. A significant number of those who attempted to find the area made arithmetic mistakes in calculating the area of the triangle.

(b) Many candidates ignored the first part of the graph and simply found the average speed for the last 40 seconds of the graph, with many making the further mistake of using a time of 80 seconds for this section.

(c) Many candidates gained full credit, although some answers lacked precision and so lost credit. A common mistake for part **(i)** was to simply write "constant".

Question 2

(a) Most candidates gained credit. Some of the weaker candidates named pieces of equipment that were not sufficiently accurate, e.g. “beaker”.

(b) The majority of candidates gained credit.

(c) There were many good answers, but the majority of candidates struggled to give a clear and concise account of the procedure needed to find the mass. The most common error was not stating clearly which quantity should be subtracted from which.

(d) The majority of candidates could recall the formula for density and evaluate the value for paraffin.

Question 3

(a) Most candidates correctly recognised that the upthrust and weight were of equal size.

(b) The majority of candidates were able to explain that the boat would start to sink if the weight was greater than the upthrust.

(c) More able candidates recognised that the boat would accelerate, and most candidates stated that the boat would move forward.

(d) Many candidates thought that the boat would stop or move backwards. Only more able candidates stated correctly that the boat would slow down.

Question 4

(a) Many candidates were able to explain that heating the ring would cause it to expand. The most common error was to state that it would melt.

(b) Many candidates gained some credit for the idea that the particles in the ring would have more energy or vibrate faster. More able candidates gained full credit by going on to explain that the particles would move further apart. Weaker candidates incorrectly stated that the particles would expand.

(c) Almost all of those candidates who scored the credit for part **(a)** went on to gain credit here also by explaining that the iron ring would contract when left to cool.

(d) Many candidates recognised that the joints in the wheel would be pushed together by the iron ring contracting.

Question 5

(a) (i) There were many descriptions of rods heating up which did not answer the question of what is *seen* happening on the rods. Many candidates either did not read the question carefully or did not understand the significance of the information that the rods were covered in wax.

(ii) Many of the candidates who did not mention the wax in part **(i)** still went on to gain full credit for part **(ii)**.

(b) Many candidates scored most or all of the available credit for this question. Weaker candidates did not mention particles in their descriptions of how evaporation causes the hot water to cool.

Question 6

(a) Many candidates scored full credit for this calculation, but a large number made mistakes when rearranging the equation.

(b) Only a small number of candidates gained full credit. The majority of candidates wanted to answer a question about echoes or changes in frequency.

Question 7

(a) (i) Very few candidates scored all of the available credit for this question. Sometimes this was caused by a lack of precision when trying to mark a distance on the diagram, but more often there was a clear lack of understanding of longitudinal waves.

(ii) There were a number of good descriptions, but the majority of candidates described how to set up a transverse wave, rather than a longitudinal wave, in the spring.

(b) (i) The majority of candidates had an idea of what one wavelength was, but were too inaccurate in their attempts at marking this distance on the diagram to be awarded credit. The question asked candidates to mark the distance *carefully*.

(ii) Many candidates did not fully recognise that the question was asking about the diagram in figure 7.2. Consequently many responses referred to having a stronger wind or throwing a bigger stone into a lake.

(c)(i)(ii) Many candidates scored full credit, but a significant number mixed up the terms amplitude and wavelength.

Question 8

(a) Many candidates gave four correct answers, but a number responded to the effect that gold and aluminium are insulators, and similarly that conductors can be charged by rubbing with a dry cloth.

(b) Most candidates scored only partial credit; usually the reason for this was a lack of detail or clarity in their response.

Question 9

(a)(i) A number of candidates could not state that the symbol represented an ammeter. Many candidates failed to gain credit through calling it an amp meter.

(ii) Most candidates ticked the correct response.

(b) (i) Most candidates answered correctly. Those who did not were evenly split between thinking either potential difference or power flowed in the circuit to create a current.

(ii) **1.** A significant number of candidates did not add the two resistors to give the combined resistance. The most common mistake was in using the formula for resistors in parallel.

2. Candidates were not penalised again for the error made in calculating the resistance and so, with e.c.f., many candidates gained all of the available credit. The most common problem was in the rearranging of the equation $V = IR$.

(c) A very large number of candidates attempted to calculate the potential difference across the 16 Ω resistor when the switch was closed instead of open as stated in the question.

Question 10

(a) The majority of candidates gained the credit. Answers such as "blow up" and "burst" were condoned, but in future series we would hope candidates would refer to the filament melting or burning out.

(b) (i) There were many good attempts at drawing the transformer symbol. Reasonable attempts at drawing a transformer were condoned.

(ii) Many candidates scored full credit. The most common mistake was the inverse of the correct answer.

(c)(i) Most candidates scored partial or full credit for this question. Irrelevant additions such as switches and ammeters were condoned.

(ii) Many candidates recognised that the value of the resistance needed was equal to the resistance of the lamp.

Question 11

(a) The majority of candidates answered correctly.

(b) Almost all candidates scoring part **(a)** went on to score part **(b)**.

(c) Many correct answers were seen, but a significant number of candidates thought that the number of protons was the same as the number of neutrons.

(d) Many correct answers were seen, but a significant number of candidates thought that the number of electrons was either equal to the nucleon number or the difference between the nucleon and proton numbers.

Question 12

(a) Many candidates correctly calculated the half-life, but some lost credit through not indicating on the graph how they had obtained their answer. A significant number thought that the half-life was equal to half of the maximum time shown on the time axis.

(b) Only the more able candidates scored all of the available credit for this section. Many candidates did not realise that another sample of the same material would have the same half-life.

PHYSICS

Paper 0625/23

Paper 2 Core

Key Messages

Apart from the basic requirement to learn information from right across the Core syllabus, there were three further aspects in which candidates could have been more careful and so have improved their performance.

In calculations, candidates must set out and explain their working correctly. When a candidate gives a wrong final answer and no working is shown, or the working is very unclear, it is often impossible for the Examiner to give any credit.

Greater care and accuracy is needed by some candidates when drawing or completing diagrams.

In order to improve their performance, candidates should practise applying their knowledge to new situations, for example by attempting questions in support materials or exam papers from previous sessions.

General Comments

A high proportion of candidates were well prepared for this paper. Equations were generally well known by most of the candidates, but a significant number struggled when required to rearrange the equations.

The questions on energy transfer and the sound and light topics were generally not well answered by candidates. There were a significant number of candidates who gave answers that were related to the topic being tested but did not answer the question, possibly because of not reading the question properly or recalling a learned response to a different question.

Often candidates had been well taught how to apply their knowledge and understanding to fairly standard situations. On occasions however, when asked to apply their knowledge to a new situation, they demonstrated some confusion and a lack of breadth of understanding. The more successful candidates were able to think through the possibilities and apply their knowledge when the question asked for suggestions to explain new situations.

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

Comments on specific questions

Question 1

(a) The majority of candidates were able to sketch most of the speed/time graph for the motion of the motorcyclist. The most common mistake was the omission of the section where the motorcyclist slowed down. A few candidates had not read the question carefully and started their sketch graph at zero instead of 15 m / s.

(b)(i) Most candidates correctly calculated the time to travel between A and B. Weaker candidates inverted the formula or multiplied the distance by the speed.

(ii) A large number of candidates indicated that the actual time would be less than that calculated in **(b)(i)**.

(c) Only the more able candidates were able to calculate the distance travelled from the area under the speed/time graph. Weaker candidates simply multiplied 20 and 25.

Question 2

(a) This description seemed to cause considerable confusion amongst weaker candidates. More able candidates gave clear, concise descriptions of how the value of the extension was determined.

(b) Many candidates gained credit for this straightforward question. Weaker candidates made the mistake of starting their line from the origin.

Question 3

(a) A large proportion of the candidates were able to identify the energy changes involved in this situation, with many scoring all of the available credit.

(b) Almost all of the candidates gained credit.

(c) Similarly, the majority of candidates were able to state what happened to the kinetic energy of the wheel when the weight hit the ground.

Question 4

(a) Most candidates scored full credit, the main source of error being inaccuracy in taking readings.

(b) (i) The majority of candidates answered correctly. The main problem came in not stating that the left hand column was lower than the right hand column.

(ii) Most candidates answered correctly, although many did choose to add the two readings instead of subtracting them.

(c) Many candidates scored full credit, but a significant number did not average correctly the two readings.

(d) A significant number of candidates suggested that the water would be too dense.

Question 5

(a) The majority of candidates selected one correct response, but only the more able ticked both correct answers.

(b) There were many creditworthy suggestions, but some candidates did not improve upon the arrangement outlined in the question.

Question 6

(a) This straightforward question gave rise to many rather confused answers, with responses ranging from “no effect” to “differences in pitch”.

(b) There were many correct responses, but the weaker candidates confused the two parts.

(c) The majority of candidates scored some credit, but only the better candidates were able to construct a short passage explaining the transmission of sound through air.

(d) Few candidates could quote two values within the required ranges of frequencies.

Question 7

(a) The more able candidates recognised that this arrangement would produce a spectrum on the screen.

(b) Very few candidates ticked only one box, which is a significant improvement on a similar question from last year. The most common mistake was to tick the box for diffraction.

(c) A large number of candidates did not use a ruler to continue the rays to the screen, and whilst many gained some credit only the most able could more fully describe what would be seen on the screen.

Question 8

(a) Most candidates gave the correct response.

(b) There were many good examples of ray diagrams, clearly showing refraction at the centre or at both surfaces of the lens. However, many candidates would benefit from further practise in drawing ray diagrams to improve their accuracy.

Question 9

(a) A number of candidates indicated that the usual purpose of a transformer was to turn AC into DC.

(b)(i) A significant number of candidates did not recall that the iron part of the transformer was called the core.

(ii) Most candidates answered the first part correctly. The calculation was often well done, but a significant number of candidates might have gained credit had they shown their working. In part **3**, the most common misconception was to state that the lamp would "burn out".

Question 10

(a) (i) Many candidates gave a correct description for charging the rod.

(ii) The majority of candidates correctly described the ball moving towards the rod as the rod was brought near to the ball.

(iii) Most candidates knew that unlike charges attract each other.

(b) Most candidates gave a correct sketch showing the balls repelling each other, but a significant number thought that they would attract, or did not draw a diagram.

Question 11

(a) The majority of candidates correctly identified the voltmeter symbol.

(b) (i) Most candidates correctly indicated the use of an ammeter, but a significant number gave the answer "amp meter" which did not gain credit.

(ii) There were many correct responses, but some candidates connected the voltmeter in parallel with the resistor instead of the cell.

(c) (i) A significant number of candidates did not attempt the question, but those who did usually gained credit for two or three of the marking points. The most common issues were the use of an incorrect equation or not giving the correct unit for resistance.

(ii) The majority of candidates ticked the correct response.

Question 12

(a) A number of candidates omitted this question. Those who did answer it mostly gave the correct answer.

(b) The majority of candidates ticked the correct response.

(c) Significantly fewer candidates gained credit here compared to **(b)**, with many candidates indicating that the answer was again "half the number at the start".

(d) The majority of candidates coped well with this question. However, there was some confusion between proton number and nucleon number. A significant number of candidates were unsure of how to calculate the number of neutrons from the nucleon and proton numbers.

PHYSICS

Paper 0625/31
Extended Theory

Key messages

Candidates for the Extended Theory Paper need to have learned the material from all topics in the syllabus, both Core and Supplement.

In addition, candidates need to take care in presenting their answers, so that credit is not lost unnecessarily. This is particularly evident in questions requiring a candidate to draw a diagram or a graph. In **Question 8(c)(i)** on this paper, for example, a second graph had to be added to one already on the paper, so that a comparison could be made between two aspects of the graphs. In some cases, one or other of the comparisons was unclear because of hurried or careless drawing.

Candidates need to remember that if time appears in a formula, such as power = energy ÷ time or current = charge ÷ time, the unit of time is seconds.

General comments

To the credit of both candidates and their teachers, much high quality work was seen in the answers on very many scripts. For the most able candidates, this quality of work applied to all or most of the questions on the paper. Many of the clearly weaker candidates were still able to show promising work in at least some aspects of the paper.

In most of the numerical questions on the paper the recall of formulae was generally good as was the subsequent substitution of numbers and the calculation. A minority of candidates do take a serious risk by only writing down the final numerical answer; no credit can then be given if that answer is incorrect.

Many candidates prepare for this examination by working with past papers in the same series. It is sometimes the case that a candidate reads a question with insufficient care, thinks that the question is the same as one on a past paper, and writes an answer appropriate to the previous question rather than the present one. On this paper there was an element of this tendency in **Question 6(a)**. Candidates need to concentrate on answering the questions exactly as they have been asked; the Examiner is looking for specific marking points and no credit is given for additional or irrelevant details.

Comments on specific questions

Question 1

Many candidates found the concepts being tested in this question difficult.

(a) (i) The idea that the liquid has a uniform expansion can be expressed in a variety of ways, but many answers did not convey this with acceptable clarity. Some candidates wrote down 'the liquid expands' or 'the liquid is mercury' or referred to the fixed points of the thermometer. These answers did not explain why the scale divisions are equally spaced, and so gained no credit.

(ii) Some candidates gained their only credit for the whole question by making one correct suggestion.

(iii) Few candidates realised that a longer thermometer would be needed.

(b) Many possible properties could have been suggested, but few candidates were able to recall acceptable ones. Many chose properties such as melting point or freezing point or specific heat capacity, clearly misunderstanding the concept of such properties.

Question 2

Almost all of the candidates produced some good answers to this question.

(a) Almost all of the candidates were able to state the formula required to calculate density. Where candidates use symbols rather than words for equations, they should be encouraged to state what each symbol stands for.

(b) A large majority were able to describe the measurements needed. Some descriptions were rather more lengthy than necessary. Time would have been saved if a 'bullet point' approach had been used with the measurements described in a sequence of instructions. It was expected that the measurements would involve the use of all or several of the coins, and those whose descriptions only used one coin did not gain full credit.

(c) A valid precaution was usually identified.

Question 3

(a) In this two-stage calculation, many candidates could quote the two formulae needed and apply them correctly. The most frequent error was the failure to use *g* in the calculation of the work done, in which case credit could only be given for 3 of the 4 marking points. The value of *g* is given on the front page of the Question Paper.

(b) Many candidates, having quoted the efficiency formula correctly and so gaining some credit, did not go on to use it correctly. The most common problems were treating the value from **(a)** as the energy input, or rearranging the efficiency formula incorrectly.

(c) Many of even the most able candidates found this question challenging. The fact that the horizontal wind has no effect on the potential energy gained or on the vertical force on the water needed to be recognised.

Question 4

(a) A good number of answers were awarded credit for at least 3 of the 4 possible marking points. Credit was given whether a triangle or parallelogram formed the basis of the candidate's approach, but in either case arrows needed to be shown on the vectors and the forces needed to be labelled. In the approach involving a triangle, the two vectors needed arrows 'head to tail', and penalties applied if these points were missed. The majority of candidates used the correct scale.

(b) Whatever the orientation of the vector diagram in **(a)**, the direction of the resultant had to be described as vertically upwards, upwards, or simply 'up'. North, or at 45° to P or Q, would not suffice.

(c) It was apparent that some candidates do not appreciate the meaning of 'magnitude', as a direction was sometimes written in the answer space. The value given needed to be the same as the resultant found in **(a)**, whatever value had been given. A few candidates mistakenly gave an answer in kg.

Question 5

(a) (i) The vast majority of candidates answered correctly. The most common error was caused by dividing rather than multiplying the mass by *g*. The front of the Question Paper gives candidates the information, 'Take the weight of 1 kg to be 10 N.'

(ii) A large majority of candidates quoted $P = F/A$ and then calculated the pressure correctly.

(b) (i) The appropriate formula was stated by most candidates and the correct pressure found.

(ii) Almost all the candidates correctly gave **Q** as having the greater water pressure on its base, but very few, in this difficult case, could give the correct reason. A small minority realised that the level of water in **Q** would fall by a smaller amount than that in **P**.

Question 6

(a) Most candidates referred to the random motion of the molecules and their collisions either with each other or the walls of the cylinder or the piston, but fewer candidates mentioned the fast speed of the molecules. A number of candidates included some details that were only required in **(b)(i)**, suggesting that they had read the question with insufficient care or were recalling an answer from a different question. Depending on the precise wording, most were able to gain some credit.

(b) (i) Almost all of the candidates were awarded some credit for stating that the pressure increases. The explanation required some reference to the increase in frequency of the collisions with the walls, not just more collisions.

(ii) A good majority of the candidates realised that Boyle's law was involved and stated the relevant formula. Almost all then worked out the final pressure correctly.

Question 7

(a) This question posed an unusual way of making the correct comparisons between boiling and evaporation. Most candidates successfully interpreted the wording and a good proportion were awarded most or all of the available credit. The most prevalent misconception was that evaporation stops when thermal energy is no longer provided. It continues, and this was the expected response. Evaporation also becomes slower, which was another acceptable response.

(b) (i) The formula $Q = ml$ was chosen by most candidates, and correctly used. Only a small minority attempted to apply $Q = mc\Delta T$.

(ii) Equal success was achieved here with the use of $E = IVt$, but some neglected to convert 20 minutes to seconds and lost some credit.

(iii) It was insufficient to suggest that energy was simply 'lost'. Credit was only awarded for adding that the energy was transferred to the surroundings, the air or the atmosphere or the pan.

Question 8

(a) It is a syllabus requirement that candidates should know typical values for the speed of sound in gases, liquids and solids; many did not.

(b) Various confused ideas were expressed. Comparatively few candidates mentioned the vibration of <u>particles</u> or <u>molecules</u>, being content simply to write 'vibrations'. More added correctly that the vibrations are in the direction of travel of the sound wave.

(c) (i) It was clear that most candidates appreciated the properties of the new wave, but some poor drawing was often seen, occasionally to the extent that no credit could be given due to, for example, large and contradictory variations in the wavelength and amplitude of the drawn wave.

(ii) The higher frequency and increased loudness of the sound were usually specified. Occasional statements such as both 'higher frequency' and 'higher pitch' demonstrated some misunderstanding of the terms, and could only be allowed partial credit.

Question 9

(a) (i)(ii) A large majority of candidates handled both calculations successfully. In **(ii)**, there were some examples of poor manipulation of the numbers in working out the combined resistance.

(b) (i)(ii) Many candidates gained full credit for correct statements of the relationships between resistance and length and resistance and area of cross-section. Some credit was given if the precise relationships were not known, but the candidate said that resistance increases with increase in length, and decreases with increase in area of cross-section.

(c) A correct response to this question required very thorough insight and careful thought. The answer was often stated wrongly as 3:1 or 3, with little or no working shown, perhaps because the answer was a guess based on the use of 12 Ω and 4 Ω. The correct answer of 1:3 or 1/3 was more often shown with some working and occurred on scripts of the best-performing candidates, though not exclusively so.

Question 10

(a) The word 'commutator' signifies changing current from a.c. to d.c. and this answer was not rewarded. Slip rings gained the mark.

(b) (i)(ii) For **(i)**, a graph showing a reasonable approximation to a sinusoidal curve was required and usually shown. A minority of candidates neglected to add the *T* for the response to **(ii)**.

(iii) Some answers were vague, stating 'more current' or 'more waves', rather than using technical terms such as amplitude, frequency or wavelength.

(c) The need for a diode or rectifier in this position was well known.

Question 11

(a) Many candidates knew the charge on the particles and what stopped beta particles. Less well known was that thick lead is needed to stop gamma rays. The weakest aspect of knowledge shown was about the nature of beta and alpha radiation, perhaps because the word 'nature' of the radiation, a syllabus term, is unclear to many. Alphas were often quoted as being helium *atoms*.

(b) A very large proportion of the candidates gained full credit. The knowledge required for the numbers of the particles in an atom is included in the Core part of the syllabus.

(c) Many correct answers followed from the writing down of a sequence of numbers obtained by halving successively the count-rate starting with 4800. Those who tried a more complicated mathematical approach often failed to reach the correct result. Final answers of 60 hours, not the extra time, were credited for 2 of the 3 marking points.

PHYSICS

Paper 0625/32

Extended Theory

Key Messages

To succeed with this paper, candidates need to be familiar with all parts of the syllabus, both Core and Supplement. In addition to the basic matter of learning, there were a number of more general ways in which some candidates could have improved their performance.

Candidates must not try to maximise their chances by giving more than one answer to a question. If two answers are given, one right and the other incorrect, the candidate will almost always gain no credit. In particular, candidates must follow the rubric of the question. There were examples in questions involving tick boxes where candidates gave more answers than instructed, some of which were obviously mutually contradictory.

Candidates must concentrate on answering the question just as it has been asked. Credit is only awarded for the specific answers required, not for comments on related matters or a general discourse about the situation.

Particularly in questions requiring extended calculation, candidates must set out and explain their working correctly. This enables the Examiner to give credit for the method even if the final answer is incorrect. Often a candidate uses an unusual method with an unclear explanation or gives no working or poor working. When an error is made in the middle of such work, it is sometimes impossible for the Examiner to see anything of merit and so no credit can be awarded.

General Comments

A high proportion of candidates had clearly been well taught and prepared for this paper. Equations were generally well known but the use of the equation and the quantities represented were not always understood. There were frequent examples where candidates substituted numbers from the question in the wrong place in equations.

There remains the tendency to think less rigorously and logically in non-numerical questions than in numerical questions.

All but the very strongest candidates would benefit from more practice in applying their knowledge in unfamiliar situations. This would deepen candidates' understanding and improve their performance in the examination. Many candidates, when asked to apply their knowledge to a new situation, become confused and unable to use what knowledge they do have. Often candidates had been well taught how to apply equations to fairly standard situations but display a lack of breadth of understanding of their use in contexts outside of a Physics laboratory.

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

The English language ability of the vast majority of candidates was adequate for the demands of this paper. A small minority of the candidates had difficulties and struggled to express themselves adequately.

In most cases it is appropriate to give final answers to 2 or 3 significant figures, and candidates should take care when rounding values. Fractions should not be used in final answers. The use of units by stronger candidates was good but overall there were a significant number of instances of forgotten or wrong units.

Comments on specific questions

Question 1

(a)(b) A large number of candidates answered these part questions as if Fig. 1.1 was a speed-time graph not the less familiar distance-time graph. In **(a)(ii)**, credit was given for calculating the speed to be 0.8 m / s instead of the expected description. In **(a)(i)** many candidates gave a numerical answer of 2.0 m / s. As the speed was varying, credit could only be given to those candidates who specified that this was the *average* speed.

(c) The vast majority of candidates gave the correct answer.

Question 2

(a) Most candidates gave an acceptable answer but many merely stated tape, which was too vague.

(b) The majority of candidates gave correct answers. The most common error was to use the equation incorrectly and carry out some division between density and volume.

(c) A number of candidates gave a clear justification for the decrease in mass and were able to earn full credit. However, many weaker candidates stated that because the pressure was the same and it was the same room the mass did not change. Other candidates suggested that the density of the air could not change. Some candidates lost credit by writing about the air (rather than molecules) moving more quickly when heated.

Question 3

(a) (i)(ii) Both parts of this question were generally well answered with no evidence of the common misconceptions. Most candidates knew the equations and applied them correctly. The most common errors in **(i)** were to try to square a quantity or merely divide energy by mass. In **(ii)** the most common errors were to use the speed calculated in **(i)** as energy or to neglect to include "*g*" in the calculations. In some cases candidates gave the impression that they had conscientiously learned the equations but lacked true understanding when substituting numbers into them.

(iii) Whilst almost all candidates gained some credit for a sensible form of energy, very few gained full credit for specifying that the water is heated. Many candidates gave very vague answers such as "energy is lost to the surroundings".

(b) This is an example of a question where good candidates were able to consider the Physics of a completely new situation, applying it logically to reach the correct conclusion. This question discriminated well between those candidates who understood the principles involved and those who were guessing. A high proportion of those who stated that the heights reached are the same, gave a good explanation. However, many candidates wrote some form of intuitive response with little or no justification based on appropriate Physics.

Question 4

(a) Many candidates gained credit here for a correct definition. Some who lost credit had tried to learn the definition by heart without properly understanding it, so some or all of their answer was confused or there were significant omissions.

(b) (i) There were many good, correct answers but again many appeared to have learnt the equation by heart but without true understanding so they were unable to make the substitution correctly. An error frequently seen in substitution was confusing the energy input with the specific heat capacity. The units for specific heat capacity are more complicated than for most quantities and overall there were a significant number of unit errors. Minor differences in the presentation of the unit, such as the omission of brackets, were condoned in this instance. Many of the unit errors appeared to be where candidates had made mistakes in remembering the unit by heart instead of understanding the principle of what was going on.

(ii) The better candidates produced good answers to this less familiar part of the syllabus. Many candidates gave the impression that they were not familiar with heat capacity as opposed to specific heat capacity and there were again many unit errors. Many candidates tried to involve latent heat in their answer, which clearly could gain no credit.

(c) Many candidates gave the most expected answer of lagging the cylinder to reduce heat losses. On this occasion Examiners condoned the statement that heat losses were eliminated (rather than reduced), although candidates should appreciate that this is not the case. No credit was gained by vague statements about repeating the experiment, which applies to almost any practical situation. In this situation, a precise mention of one of many specific steps that can be taken to improve accuracy gained full credit.

Question 5

In this question, a number of candidates did not express their ideas clearly and might benefit from further practice in writing extended answers.

(a) (i)(ii) Most stronger candidates gave good answers to both parts and scored full credit. Some candidates, however, neglected to make a clear unambiguous statement about the effect on the rate of evaporation. To gain full credit in **(i)**, candidates needed to describe processes which involve taking the molecules away after evaporation from the surface, rather than suggesting that the wind is an agent involved in actually removing the molecules from the liquid water. The reasoning in **(ii)** was more successful.

(b) Many candidates gained full credit here. In some cases, however, credit was lost because the explanation described which puddle was likely to take the shortest time to disappear rather than referring to the rate of evaporation of water.

(c) There was a wide variety in the quality of answers to this part even among stronger candidates. There were a significant number of appropriate and well described experiments by candidates who had obviously carried out and learnt such experiments. Other good answers were from candidates sufficiently well grounded in the subject matter that they were able to devise a viable experiment. The main confusion was between an absorption experiment and an emission experiment. Many answers described the experiment so vaguely that it might have been either, and many experiments required objects to be involved in both absorption and emission. Some candidates gave answers involving the detection of radiation from radio-active sources or the use of infra-red remote control devices. There were also a significant number of candidates who gave no response to this question.

Question 6

(a) Most candidates drew careful, accurate diagrams and gained full credit. Candidates should have a ruler and protractor available for all science papers.

(b) Most candidates gained full credit but a few ticked more boxes than one on each line of the table so inevitably lost credit. Candidates should be made aware that giving more than one answer in this way will never be successful.

(c) Nearly all candidates made a good attempt at applying the Snell's Law equation. However, as many applied it upside down as the correct way up and reached an answer of 22°. Candidates should be advised to think about their answers in general as well as numerical terms. A quick thought, that light passing from water to air is refracted away from the normal, would have provided a check that the equation had been applied the correct way round.

(d) Most candidates gained full credit for this part question. A significant number did not answer the question and merely drew a ray emerging from the prism but no ray in the prism. In this part, as well as in **(a),** a reasonable amount of care and precision in drawing is expected. A small minority of candidates appeared to know the Physics but lost credit due to poorly drawn answers.

Question 7

(a) This was mostly well answered.

(b) (i) This was well answered by nearly all the stronger and middle-range candidates. Some candidates had not to read the question carefully and gave a variety of answers. Frequently the magnetic field from the wire or the combined field of the magnet and the wire was given. Also many candidates gave two unlabelled arrows, possibly one for the field in **(i)** and one for the force in **(ii)**, but without a way of distinguishing these no credit could be given.

(ii) This was generally well answered by stronger candidates but quite a few had the direction to the left rather than to the right. Possibly they applied the rule for the wrong hand.

(c) Many candidates answered very well and gained full credit. A common error among mid-range candidates was to substitute the value of mass in grams. Many weaker candidates incorrectly rearranged the $F=ma$ equation.

Question 8

(a) Many candidates gained full credit on this part.

(b) There was a wide variety in the standard of answer. The were many excellent answers but errors included thinking that there were three resistors in parallel and failing to invert the sum of the reciprocals. A significant number of candidates lost credit for expressing their answer as a fraction.

(c) Relatively few candidates were able to correctly complete this question. Most managed to use the correct equation for $V=IR$ but in order to gain full credit candidates needed to apply it to the correct voltage and resistance in order to determine the current in the 4Ω resistor.

(d) There was a wide variety in the quality of responses. Strong candidates invariably gained full credit. Among popular incorrect responses were 3.0 V, 0 V and even 4.5 V.

Question 9

(a)(b) The majority of candidates gave good answers to these part questions and gained full credit.

(c) Most candidates were aware that the wire should be removed first but many of the explanations were very vague. Many of the incorrect answers involved the movement of positive charges.

(d) Many candidates used the word induction but some could not be given credit as they stated some inappropriate type of induction, especially electromagnetic induction.

Question 10

(a) This was well answered by a clear majority of candidates.

(b) Most candidates gained credit here but candidates should be aware that drawing a symbol does require care and accuracy. Some candidates appeared to try to cover all possibilities by drawing an OR gate on one side and an AND gate on the other side. They should be made aware that such attempts will not gain any credit.

(c) Many candidates did well on this part question. Some candidates drew circuits with 3 inputs, which could never be equivalent to a NAND gate. Variations of Fig. 10.1 were often seen with AND and NOT gates drawn in place of the boxes.

Question 11

(a) There were many entirely correct answers here but also a wide variety of errors. In particular many candidates did not follow the instruction to place one tick in each column of the table. Additional ticks will always cancel out any credit already gained for a correct tick.

(b) Many candidates were on the correct lines with comments about becoming charged or losing or gaining electrons. To gain credit it was also necessary to state that atoms or molecules were involved in the charging process.

(c) Many candidates gained some credit for correctly stating some properties of alpha-particles or gamma-radiation. Answers that gained full credit also explained how these properties were related to the ionising properties and range. Some candidates merely repeated the information in the question using a slightly different wording, and so gained no credit.

PHYSICS

Paper 0625/33
Extended Theory

Key Messages

This paper is designed to test the entire syllabus, both Core and Supplement, although the majority of the parts deal more extensively with the Supplementary material than with the Core material.

In addition to being familiar with the entire syllabus, candidates must also be able to give answers in a variety of ways and to be able to relate one style of explanation to another. Candidates are required to be able to interpret information from graphs and to perform calculations accurately using formulae which are known. Although a high standard of art work is not necessary, candidates are sometimes required to draw diagrams which are clear and comprehensible. Where a verbal explanation is required, candidates need not be too concerned with the grammatical accuracy or elegance of the answer, but it must be clear and unambiguous and it must, of course, deal with the point being examined.

All numerical answers must be followed by the correct unit and, where the calculated answer runs to many decimal places, the answer given should be correctly rounded. There remain a few candidates who do not give units and who receive a reduced credit as a consequence.

When answering a question, it is important that a candidate restricts the answer to exactly what is being asked; otherwise, contradictions can be produced which invalidate a correct comment that has already been made.

General Comments

There are candidates who spend some of the allocated time writing out answers in pencil and who then trace over these answers in ink; this is at the very best a poor use of time but it may also ensure that the answer is significantly less clear than it otherwise would be, and in some cases credit may be lost when the Examiner cannot be sure what answer is intended. This practice should be vociferously discouraged.

The amount of answer space provided for written answers should be sufficient for an answer that obtains full credit, and candidates who write lengthy answers in small handwriting are prone to lose credit by including material that is contradictory. No answers should be written on the front cover and where an answer continues beyond the answer space, a simple reference to the location where the answer continues should be made. For questions involving calculations, the working needs to be clearly set out in order for the Examiner to give it credit.

Comments on Specific Questions

Question 1

(a) This part was answered correctly by the overwhelming majority of candidates. A very small number of candidates reversed the answers to part **(ii)** and part **(iii)** but very few other errors were made. It was especially encouraging that very few candidates indeed marked letter A where the car is stationary. Although the speed of the car is constant as asked, the car itself is not moving.

(b) (i) Very few candidates were able to obtain full credit here. Not all candidates realised that the acceleration could be obtained from the change in velocity of the car or that this could be obtained from the graph. Many of those who tried to apply the standard definition of acceleration to values obtained from the graph, used a value for the time taken of 6.5 s rather than a value for the change in time that was obtainable from the graph. Acceleration is not a straightforward topic and this common source of inaccuracy suggests that there are many candidates who can recall a formula for acceleration but do not understand what it really means.

(ii) Some candidates had very little idea of what was required here. However, many candidates knew the formula needed and were able to obtain full credit either by giving the correct answer or, more commonly, by correctly using their incorrect value from **(i)** which had already been penalised.

(c) There were many correct answers, with a majority of candidates realising that the absence of a resultant force ensured that the car was travelling with a constant speed.

Question 2

(a) This part was very well answered and very many candidates obtained full credit here. A few candidates used a beaker rather than a measuring cylinder and did not obtain full credit, whilst others did not mention one of the readings which were needed in their answer. A few candidates gave a full description of the determination of density rather than the determination of volume.

(b) (i) This was almost universally correct.

(ii) This was extremely commonly correct. A very few candidates supplied the ratio upside down whilst others used the term *weight* rather than *mass*. Full credit was obtained very frequently.

(c) This part of the question was also well answered with nearly all candidates describing a method based on using the lead weight to make the piece of wood sink. Although the correct answer could be obtained from just two readings, many candidates suggested the use of three readings. In some instances, this led to a lack of clarity as to which readings were being subtracted in order to obtain the volume of the piece of wood.

Question 3

(a) This was generally very well answered with a very large number of candidates obtaining full credit.

(b) (i) Many candidates obtained the correct answer by using the principle of moments correctly. The answers of some candidates did not suggest an understanding that the use of moments was needed here and an answer was obtained by using proportions; this usually gave a weight for the apple that was less than that of the weight used to balance it.

(b) (ii) This part was quite poorly answered. Only a minority of candidates gave a mass that was consistent with their answer for **(ii)**. Some candidates multiplied by *g* rather than dividing by it; others confused grams with kilograms and some candidates did not use the answer in **(i)** at all.

(c) (i) Few candidates made any mention of moments in this part and only rarely was full credit obtained. The suggestion that the weight of the apple plus the weight of the part of rule on that side of the pivot was equal to the weight of the part of the rule on the other side of the pivot was commonly made.

(c) (ii) Many candidates were successful with this part question.

Question 4

(a) (i)(ii) Although many candidates had some idea of what was needed here, full credit was only occasionally obtained. The points being assessed were primarily the separation of the molecules and the randomness of the arrangements. Some answers were not especially clear as the molecules drawn were of varying sizes and separations and included arrangements that were a mixture of randomly positioned molecules as well as clearly non-random arrangements.

(b) (i) The correct state of matter was very commonly underlined here.

(ii) Very few answers referred to the absence of the repulsive intermolecular force that opposes the compression of solids and liquids but many candidates made correct references to the large intermolecular spaces in gases.

Question 5

(a) Some candidates obtained full credit in this part but others did not get as far as the correct final answer. A common source of inaccuracy was to calculate an incorrect value for the energy supplied; in many cases the time period of 180 s was ignored whilst in others the power was divided by it.

(b) (i) This was quite well answered and a significant number of candidates obtained full credit.

(ii) This question asks for two ways in which evaporation differs from boiling. Those candidates whose answers concentrated on boiling did not always make it clear how this related to evaporation, and full credit was commonly not obtained by such candidates.

Question 6

(a) (i) Only the correct letter was needed here and a large majority of the candidates gave the correct answer.

(ii) In addition to the correct letter, an explanation was needed, and a significantly smaller number of candidates scored credit. Candidates had difficulty explaining that thermometer E is the most sensitive because it has the smallest range and the greatest length.

(b) There were many answers here which incorrectly suggested that the sensitivity of a thermometer is determined by the thickness of the glass in the bulb. It is possible that candidates who gave this erroneous explanation mistakenly thought that sensitivity describes the speed at which a thermometer reaches its final reading. Full credit was only rarely obtained.

(c) This calculation proved challenging for many candidates. Many did obtain some credit for showing part of the working, but rather fewer obtained full credit. The fact that the range of this thermometer extends from –10 °C to 110 °C seemed to complicate the problem considerably for many candidates. The effect of the ten degree Celsius section at each end was only occasionally dealt with correctly.

Question 7

(a) This part was not well answered. Some candidates did not refer to vibrations or oscillations at all whilst others suggested that it was the wave itself that was vibrating. Many answers stated that a transverse wave moves in a direction at right angles to the wave direction, which is unclear or self-contradictory.

(b) (i) The relevant formula was widely known and the correct numerical substitution commonly gave the correct answer here. There were candidates who produced unclear formulae such as $w = \lambda s$. Many candidates, however, obtained full credit. Some others obtained the correct numerical answer but gave the wrong unit; a typical example was 813 m.

(ii) The answers here were not widely known and the answers given were very commonly inconsistent with each other.

Question 8

(a) (i) A significant number of candidates knew where the image was located but rather fewer candidates were able to show how to locate the position using the reflected rays. Very few candidates obtained full credit.

(ii) Although the answers given were mixed and occasionally contradictory, most candidates gave one or two correct characteristics of the image.

(b) This was generally sensibly answered and many candidates obtained full credit.

Question 9

(a) The answers given varied enormously in quality and accuracy. It was encouraging to see neatly drawn sets of equally spaced vertical field lines which obtained full credit. Some candidates, however, drew horizontal lines or the trajectory of what might have been a charged particle passing through the gap. It is possible that a candidate who did this has attempted to learn by heart answers from significantly different questions in previous papers.

(b) (i) This was well answered and many candidates obtained full credit. A few candidates struggled with the powers of ten but were still able to obtain some credit. The erroneous equation $I = Qt$ was quoted surprisingly frequently.

(ii) Many candidates were aware that the conduction property is due to electrons but rather fewer stated explicitly that the electrons are free to move through the structure.

Question 10

(a) This was very commonly correctly answered; the correct formula was widely known and frequently used appropriately.

(b) This part was quite involved and, in order to obtain the correct answer, more than one stage in the calculation was required. Many candidates obtained some credit and a significant number were able to obtain full credit for the correct answer with the correct unit.

Question 11

(a) (i) Whilst many candidates obtained some or full credit here, there were also those candidates who did not know how to proceed and who left this part blank or who combined the numbers given in the question in an unsystematic manner.

(ii) Electromagnetic induction is frequently poorly understood and only a minority of candidates produced an answer that was clearly correct. Some credit was obtained by candidates who referred to the changing magnetic field but a common misunderstanding was to suggest wrongly that there is a current in the iron core transferring energy to the secondary coil.

(b) Many candidates knew the name of the appropriate component and the majority of candidates knew its significant property. This was well answered.

Question 12

(a) Although questions on this topic occur not infrequently, this question was rather poorly answered. A common misunderstanding suggests that the high voltage of transmission reduces the resistance of the cable. It does not and the suggestion that it does reduces the credit that a candidate would otherwise have obtained.

(b) (i) Most candidates stated that the resistance of the cable would be reduced when its diameter is doubled. Of those who attempted a quantitative response, the majority suggested that the resistance would be halved. Only a very small minority of candidates obtained full credit here by correctly stating that the resistance would, in fact, be reduced by a factor of four.

(ii) Many candidates produced a correct disadvantage here but others did not do so.

PHYSICS

Paper 0625/04
Coursework

General comments

This year saw a significant increase in the number of Centres entering for coursework assessment. Regular Centres continued to produce work of the correct standard to justify the credit awarded and used tried and tested investigations which allow candidates to show their abilities to the best effect. This was also true of the majority of new Centres.

There were, however, a number of Centres where the credit awarded did not accord with the standards expected. In these cases it was due either to teachers at the Centre being too generous in their marking or, more commonly to Centres choosing assessment tasks which were not appropriate to the skills being assessed.

The majority of samples illustrated clear annotated marks and comments, which was helpful during the moderation process. The candidates at the majority of Centres were given many excellent opportunities to demonstrate their practical skills using a varied range of tasks from different areas of the specification; clearly a large amount of good work has been completed by teachers and candidates.

If more than one teacher has been involved in the assessment of practical skills, then it is very important that internal moderation is undertaken, to ensure that the standards applied for all candidates are comparable. This is made easier where all candidates do the same tasks, and the same mark schemes are used. It is acceptable to use different tasks, but this will require considerably more effort to be made to ensure that marks for one teaching group can be compared directly with those of another. It is best if just one teacher takes on the role of internal Moderator, as this is the only way to ensure that the same standards have been applied for the entire entry from one Centre. The external Moderators cannot change the rank order within a Centre; it is the Centre's responsibility to ensure that this is correct.

Skill C1 Using and Organising Techniques, Apparatus and Materials.

This skill involves following instructions and as such cannot be combined with skill C4 which involves writing instructions. The credit awarded depends on the complexity of the instructions followed, which may be simple one step instructions, more complex multi-step instructions, or instructions which are branched, that is where there are, at some point, two possible routes to take. The decision as to which route is taken depends on interpretation of an observation.

Skill C2 Observing, Measuring and Recording.

This skill involves making and recording observations. Tasks may be quantitative, involving measurements of qualitative observations. Care must be taken not to provide too much guidance on exactly what to observe and how to record it. The provision of tables and other formats, even in outline, limits the credit which can be awarded.

Trivial exercises involving one or two readings are not sufficient evidence for the higher credit.

Skill C3 Handling Experimental Observations and Data.

This skill involves processing results and finding patterns to arrive at a conclusion. It is much easier to demonstrate this skill if there is data to process. Most suitable of all are tasks from which a graph is produced as this makes it easier to find and explain patterns.

Again care must be taken to not give too much help in the way of leading questions or pre-drawn axes. In this skill also, such assistance lowers the credit available.

Skill C4 Planning and Evaluating Investigations.

Here a detailed plan must be written before the investigation is started. It is also essential that the plan is then carried out as this enables an evaluation to be made and improvements suggested.

Very simple exercises are not really suitable as there must be opportunity to explain how variables are to be varied, measured or held constant.

Mark schemes should be related both to the task and to the criteria in the syllabus and should not be a slight rewording of the assessment criteria.

PHYSICS

Paper 0625/51

Practical Test

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 on the significance of results, precautions taken to improve reliability and control of variables. In this examination, lack of personal experience was particularly noted in **Question 4**.

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
- tabulation of readings
- graph plotting and interpretation
- manipulation of data to obtain results
- drawing conclusions
- understanding of the concept of results being equal within the limits of experimental accuracy
- dealing with possible sources or inaccuracy
- control of variables
- choosing the most effective way to use the equipment provided.

The general level of competence shown by the candidates was sound. Many candidates, who appeared to have had a good level of practical experience, dealt well with the range of practical skills tested. The candidates who scored the highest marks were able to answer with confidence the sections involving careful thought about techniques or the significance of results.

Some candidates have clearly had access to the mark schemes from past papers. It should be realised that these are written primarily for Examiners. Answers such as, ‘Statement to match readings’ or ‘Justified by reference to the readings’ show the learning of mark scheme instructions rather than understanding of the questions.

Comments on Specific Questions

Question 1

(a) Most candidates successfully measured the length.

(b) Most candidates measured the new length and calculated *e* correctly. This part gave an opportunity for candidates to show their understanding of units. However, many candidates gave no unit.

(c)(d) Most candidates recorded a suitable value for *t* and calculated *T* correctly. The value for *T* was expected to be given to two or three significant figures. The unit, s, was correctly stated by most candidates and many showed that they had carried out the experiments with care by obtaining values for the times that were within the allowed tolerance.

(e) Here candidates were asked to think carefully about the experiment and make a judgement on the results. A significant number of candidates assumed that the results would support the suggestion and justified this by claiming that the results were within the limits of experiment accuracy.

Successful candidates, however, realised that the results did not support the suggestion and were able justify their statement with reference to the results, for example by stating 'the difference is too large to be explained by experimental inaccuracies'. Unfortunately many who made a correct statement did not justify it but merely quoted the results without further explanation. (Suitable allowance was made for candidates whose readings were not those expected but who drew a correct conclusion from their readings.)

(f) Many candidates gained credit by clearly showing on a diagram the importance of viewing the scale perpendicularly.

Question 2

(a) Most candidates successfully recorded the temperature.

(b) Most candidates correctly recorded the units (s, °C, °C).

(a)-(d) Most recorded the correct times and displayed readings that showed the expected trends of decreasing temperature with a greater rate of cooling without insulation.

(e) The majority of candidates realised from the table that the rate of cooling decreased with the insulation. To score full credit, candidates needed to illustrate this by reference to their results, for example by showing a suitable pair of temperatures drops.

(f) Here candidates had the opportunity to show their understanding of the control of variables and needed to carefully select one condition. The Examiners looked for sensible comments relating to room temperature, starting temperature or the amount of cotton wool.

Question 3

(a) Many candidates recorded the voltage to at least 1 decimal place and the current to at least 2 decimal places, as appropriate to the meters they had been provided with. Most candidates successfully calculated the resistance.

(b) Here, candidates who had carried out the experiment correctly, and with care, obtained a value of current that was greater than the previous value. Candidates then had the opportunity to show their knowledge of units for voltage, current and resistance.

(c) The value of resistance was expected to be given to two or three significant figures, as is appropriate from the raw data from which it was calculated.

(d) Many candidates were able to write a correct statement of what their results showed.

(e) It was pleasing to see that many candidates thoughtfully wrote about the difficulty in placing the sliding contact in exactly the same position. Other sensible answers were also credited.

(f) Candidates who understood how to interpret the data represented by the graph line were able to comment that the line showed an increase in resistance and to explain the reason for their answer. Less confident candidates could only make a comment on the reason that was too vague to score.

Question 4

Ray-trace Many candidates drew a neat, accurate ray-trace, following the instructions with attention to the details. The candidates are expected to use a sharp pencil, ruler and protractor with care to demonstrate their practical skill. Some candidates appeared to have had little experience of using a plane mirror (or had forgotten what they had learned) and produced a ray-trace that did not entirely relate to the instructions.

Table Candidates who carried out the procedure with care were able to obtain readings within the tolerance allowed.

Graph Many candidates were able to label the graph axes correctly and choose a scale that made good use of the grid. Plotting was generally accurate, but a significant number of candidates did not gain the credit available for the scale, by choosing a scale that was too small. Some candidates did not gain credit for the graph line, usually by drawing a 'dot-to-dot' line rather than a best-fit line.

PHYSICS

Paper 0625/52
Practical Test

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 on 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.

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 of readings
- graph plotting and interpretation
- manipulating data to obtain results
- drawing conclusions
- understanding the concept of results being equal to 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 the 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 every 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 invariably included, writing was neat and legible and ideas were expressed logically. However, many candidates seemed less able to derive conclusions backed up by evidence, or to present well thought out conclusions.

All questions provided opportunities for differentiation, but particularly good was **Question 2** where the analysis of the best-fit graph line, and relating its shape to the rate of cooling of the water, allowed the better candidates to demonstrate their ability. The gathering and recording of data presented few problems for any candidates. There was evidence of some candidates not having the use of a calculator.

The ability to record readings to an appropriate precision, usually reflecting the measuring instrument used, or to quote a derived result to an appropriate number of significant figures, 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 choosing an appropriate scale to plot their graphs and in drawing a best-fit line to display their data.

There were more 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 the 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 measured the required dimensions of the pencil with care, and gave answers to the nearest millimetre.

(b) The majority of candidates were content to wrap one turn of string around the pencil and then measure the length of this one turn in order to determine the circumference of the pencil. Only the more able candidates wrapped more than one turn of the string around the pencil in order to obtain a longer length to measure, and then divided their length by the number of turns taken. A number of candidates attempted to wrap all of the given length of string around the pencil, nearly always arriving at a fractional turn, which was then rounded before dividing. This is poor experimental practice, and was not credited.

(c) There were many sensible suggestions of sources of inaccuracy in determining the circumference in this way, although a sizeable minority of candidates thought that the millimetre scale was too inaccurate for this experiment.

(d) This part merely required candidates to insert their measured values into the given equation in order to determine the volume of the unsharpened section of the pencil. Although most candidates calculated correctly, many spoiled their answers by incorrectly rounding them, or by quoting them to an inappropriate number of significant figures. Only a minority of candidates were penalised by quoting the volume with an incorrect or missing unit.

(e) This more demanding final part involved the estimation of the volume of the sharpened section of the pencil and it is pleasing to report that there was much sensible and sound reasoning seen. The more able candidates invoked the formula for the volume of a cone, and received full credit. Any method which involved the substitution of an 'average' value of c into the given formula, or where the final calculated value of the volume of a cylinder was reduced by an appropriate fraction, was given full credit. Many candidates, however, merely used c and x in the given formula, without any scaling down and received no credit.

Question 2

(a) Most candidates gained the two marks awarded for taking the temperature of the water every 30s and recording their results in the table. The occasional incorrect or missing unit for the temperature was seen.

(b) Many candidates started their y-axis from 0, instead of using a restricted scale on the temperature axis to facilitate the plotting of their temperatures. Because the temperature change of the cooling water was generally small over the three minutes that candidates were measuring the temperature, the y-axis scale of their graphs was such that the plots did not fill half of the given grid, and so some credit was lost. This having been said, there were many examples of good scales being used to accommodate this small temperature change. Some candidates lost the credit for the graph line, as many best-fit straight lines were seen, even when the plots indicated a clear curve.

(c) Although the shape of candidates' graphs was generally described adequately, many candidates did not go on to state what the graph line that they had drawn told them about the rate of cooling of the water. A common incorrect response from candidates who had drawn a best-fit straight line on their graph was to state that the rate of cooling of the water decreased – these candidates were attempting to use theory, and not the results that they had obtained.

(d) Most candidates were aware of the correct way to read a measuring cylinder in order to obtain an accurate value for the volume of water that it contained. The quality of the descriptions as to how parallax could be avoided was very variable, and most candidates were awarded this mark from the diagram that they had drawn, and not from the description. Candidates who referred to taking the measurement from the bottom of the meniscus, met with more success.

Question 3

(a) The potential difference across the resistor and the current in the circuit were usually recorded, and were within the tolerance limits set. Some candidates quoted their value to too few or too many decimal places. It was also apparent that some candidates were clearly recording an answer in mA, but quoted A as the unit – this might perhaps be due to the apparatus with which they had been provided, making it difficult for them to see, although they should be aware that currents of that size would not be used in the laboratory. The resistance of the resistor was usually calculated correctly, but with the occasional error in rounding, which was penalised.

(b) The measurements taken here were the same as in part **(a)**, but with the sliding contact having been moved. The comments in part **(a)**, equally apply here.

(c) Most candidates gave correct units for the electrical quantities measured, with very few candidates omitting units altogether. The resistance of the resistor was usually calculated correctly, but all too frequently its value was rounded to one significant figure.

(d) This was less well answered than the rest of the question, with candidates having difficulty in expressing how the value of the resistance changed as the current changed, because they did not take the limits of experimental accuracy into account.

(e) There were many good answers to this part, with most candidates being able to explain how to determine the gradient of a straight line graph. Occasionally when candidates attempted to use the given graph diagram to explain the gradient calculation, they drew their two chosen points far too close together. Weaker candidates were content to take one data point off the given line, and to divide the y coordinate by the x coordinate, for which no credit was awarded.

(f) The circuit symbol for a variable resistor was generally well known, but the standard of diagram drawing was poor. Where marks were lost, it was because candidates drew diagrams of thermistors, or hybrids of these or potentiometers.

Question 4

It became obvious when marking the work of some Centres that their candidates had not been provided with convex lenses of focal length 15 cm as specified in the Confidential Instructions. Centres should notify Cambridge in advance if they are making any changes to the apparatus provided, to ensure that the change is acceptable and will not adversely affect their candidates. The Supervisor's Report must also include details of any changes, for whatever reason, made to apparatus supplied to candidates, so the Examiners can give candidates full credit for carrying out experimental procedures correctly.

(a)(b) Many correct answers were seen in this question, although it became clear to Examiners when marking later parts of the question that the instruction to make distance D = 80.0 cm and **not** to change it, had not always been followed. The use of incorrect lenses also contributed to producing odd values for x and y by some candidates.

(c) The sum of the candidates' values of x and y was generally within the accepted range, showing that good experimental skills had been employed in locating the image positions and measuring the distances.

(d) The values of d and d^2 were nearly always calculated correctly.

(e) The actual calculation of the focal length was usually done correctly. Answers were expected to two or three significant figures, with a correct unit, and this proved to be the case with a majority of candidates. The accuracy mark, i.e. the mark for arriving at a final value of focal length which was within ± 1 cm of the value of the focal length of the lens used, was less frequently awarded.

(f) Almost all candidates were able to give one acceptable precaution and many gave two. General answers such as 'measure accurately' and 'avoid parallax' should not be given, as they are far too vague.

(g) Almost all candidates had noticed that the image seen was inverted, and the sketches drawn were almost invariably correct.

(h) Many candidates suggested correctly that the variable that could be changed was *D*. A popular incorrect response was the lens to object distance.

PHYSICS

Paper 0625/53

Practical Test

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 on the significance of results, precautions taken to improve reliability and control of variables.

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
- tabulation of readings
- graph plotting and interpretation
- manipulation of data to obtain results
- drawing conclusions
- understanding of the concept of results being equal within the limits of experimental accuracy
- dealing with possible sources or inaccuracy
- control of variables
- choosing the most effective way to use the equipment provided.

It is assumed that, as far as possible, the IGCSE course will be taught so that candidates undertake regular practical work as an integral part of their study of physics. Questions on experimental techniques were answered much more effectively by candidates who clearly had regular experience of similar practical work and much less successfully by those who, apparently, had not.

The practical nature of the examination should be borne in mind when explanations or justifications are asked for. This was seen in some of the excellent, straightforward responses to **Questions 2(d)** and **3(e)**, which required references to results rather than theory, and in the clear practical details given by some candidates in **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 **Questions 1, 3(e)** and **4(a)**. Candidates should be aware that the appropriate use of significant figures and the inclusion of units where appropriate, will be tested at some point in the Practical Test.

The relationship between the variables plotted in **Question 4** was most likely to indicate a clear curve. Many candidates recognised this possibility while others attempted to fit straight lines to plotted points which did not justify them. Candidates need to be aware that graphical questions may well have plots which indicate a smooth curve rather than a straight line.

Comments on specific questions

Question 1

Good responses to this question were seen from a number of candidates, although the later sections proved challenging for many.

(a) The majority of candidates recorded sensible values for the masses and for the volume of water. The resulting density was generally calculated accurately. As units for the mass and volume were given in the question, it was expected that the density would be expressed in g / cm^3. This was generally the case, with Pa or omission of the unit being the most common errors.

Credit was given to candidates who converted correctly to kg/m^3 but this was rarely seen.

(b) Most candidates recorded an appropriate mass and volume and the difference in volume was usually calculated accurately. Density was often expressed to the expected 2 or 3 significant figures, as was appropriate for the volume and mass measurements from which it was calculated.

It was clear from a very small number of responses that the instruction in part **(a)** to leave the water in the measuring cylinder had been ignored, resulting in inaccurate values of water displaced following the necessary refilling of the measuring cylinder. This underlines the need to read and follow the instructions carefully.

(c) While an average value of density from the results obtained in parts **(a)** and **(b)** was calculated correctly by the majority, the use of ($\rho_1 + \rho_2$) or (ρ_1 / ρ_2) was seen.

(d) This question called for candidates to focus on the reading of the volume as carried out in part **(a)**. Many good answers, including diagrams, described the line of sight needing to be perpendicular to the reading, taken from the bottom of the meniscus. Either point was given credit. Answers involving the use of different measuring cylinders with more precise graduations were not acceptable.

(e) Many candidates found this question challenging. Although a number suggested a possible source of inaccuracy, few were able to correctly state and explain the effect on the value of density obtained. The most straightforward correct answers, both resulting in a larger value for density, identified that the balance may not be set to zero, producing a larger value of mass, or that friction between the test-tube, which did not float upright, and cylinder may result in a smaller displaced volume of water. While it is recognised that this would have a minimal effect, credit was given to those candidates who noticed that some of the mass of the cotton was supported by the edge of the cylinder rather than contributing to displacement of water.

Question 2

This question was done well by many candidates.

(a) Decreasing thermometer readings were recorded by the majority of candidates. Candidates should be advised to estimate to the nearest 0.5 °C if the thermometer provided allows this, rather than recording integer values. This helps to avoid a number of identical readings together and better show the trend in the case of temperatures which are decreasing slowly, as was often the case for beaker **A**.

It was usual to see the units and column *t* values inserted correctly, the latter usually including 0. Units are not required for each value of temperature recorded if the units are present in the column headings. The practice of attaching units to the data in the columns as well as the headings should be discouraged. On occasions, contradictions between the two were seen and could not be accepted.

(b) A measurably greater rate of temperature decrease in beaker **B** compared to beaker **A** was generally experienced. However, where candidates had not used fresh hot water but poured in water which had already cooled significantly, this difference was much less marked or sometimes reversed. While subsequent responses were judged on the results which candidates had obtained, it is obvious that some were confused by patterns which did not fit those that they might have expected. Centres must ensure that, in such experiments, fresh hot water is clearly available.

(c) The clearest pattern of temperature change likely to apply to both beaker **A** and beaker **B** was that the rate of temperature decrease at the start of the experiment was greater than at the end. A number of candidates were able to identify this but many described more complicated patterns, few of which applied to both beakers or were consistent throughout the experiment. Description of any genuine similarity was accepted.

(d) Some good simple answers were seen, in support of the suggestion, pointing out that the temperature change in beaker **A**, with the larger volume of water, was smaller than that for beaker **B** in the same time interval. Others calculated and compared the average rate of temperature change over 180 s. A number of candidates omitted the reference to time interval and did not gain full credit.

It should be noted that a lower final temperature of beaker **B** was not acceptable as sufficient evidence if starting temperatures were not included in the justification.

(e) Good responses to this question were generally seen, with 'initial temperature of hot water' and 'room temperature' being common correct answers. Correct references to the dimensions of the beaker, the depth of the thermometer bulb and the volume of water were frequently seen.

Question 3

This was a question, involving some straightforward measurements, and many candidates were able to answer very successfully.

(a)(b)(c) Sensible values, recorded to at least 1 decimal place for potential difference and 2 decimal places for current, reflecting the precision of the meters provided, were seen in the work of most candidates. There were some large results for current that seemed to indicate the use of scales recording in mA, although the units were still given as A in these cases. If multimeters are supplied, Centres should ensure that this does not disadvantage their candidates.

(d) Correct units for V and I were usually given. Some candidates omitted the answers, possibly through not having read the question fully, and others gave the quantity, i.e. 'voltage', 'current', rather than the unit.

(e) The values of resistance were often determined accurately and included a correct unit. Although the data generally implied that resistance should be expressed to 2 significant figures, 3 significant figures were also acceptable. Candidates should not express calculated quantities such as resistance to a precision greater than is justified by the raw data used.

Responses to this question were judged against the results which had been obtained rather than the attempts by some candidates to use a theoretical argument. Many correct answers, matching the results and supporting the suggestion, were seen. Justifications were often that the difference between R_A and (R_B + R_C) was within the limits of experimental accuracy and a number of candidates reasonably quoted 10% as their expected limit. Where results clearly did not support the suggestion, candidates often did not give a justification declaring the difference to be outside the limits of experimental accuracy. Candidates often incorrectly disagreed with the suggestion because the two values were not exactly the same, even though they were extremely close.

(f) This question required candidates to consider precautions which could be taken in this type of experimental work. Straightforward techniques of using smaller potential differences and currents or, as most would have done in this practical, switching off between readings, were given credit, although only a minority of candidates gave such responses. Candidates should be aware that using wires with a larger cross-sectional area, a common incorrect answer, would have the effect of increasing the temperature rise rather than reducing it.

(g) A large number of candidates answered this question correctly, showing the symbol as a rectangle with a diagonal arrow through it and indicating a connection in the series part of the circuit. A common error was to draw a thermistor symbol or a plain diagonal line and the connection was sometimes incorrectly shown between the crocodile clips.

Question 4

This was the question that was least well done by many candidates with the explanations and the curved line of the graph being found particularly challenging.

(a) Many of the candidates were able to record a set of appropriate measurements in the table, with both variables increasing and expressed to at least 1 decimal place.

(b) Although most calculations were correct, some rounding errors in the s value were seen.

A number of candidates did not take into account that their measurements of *w* and *h* were not always the same, despite recording them as different. However, some correctly pointed this out. Others were given credit when they reported that the blurred edges of the shadow made measurements difficult and that taking an average value would improve reliability.

(c) Some good graphical skills were seen, with clearly labelled axes, appropriate scales which allowed the plotted points to occupy at least half of the grid, and accurate plots shown with fine crosses. The advice is that plotted points should, preferably, be marked with small fine crosses. 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 a significant 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.

Although it was usual that plotted points clearly indicated it, only a minority of candidates were able to produce a smooth well-judged curve. Many drew a straight line or used smaller straight lines to join the plots together. Many physical quantities have a relationship which will produce a curved line on a graph and candidates should be prepared for this.

(d) It was expected that candidates would take into account the increasingly large differences, which most experienced, between successive values of *s* and recognise the need for an intermediate point so that better line judgement could be achieved. Only a minority of candidates explained this adequately. The common response that 'more plots produce a more accurate line' did not sufficiently address the need for the intermediate point to be here rather than between other values on the *d* axis.

(e) Many candidates recognised that a shadow for distances of less than 15 cm between the lamp and the object would be too large to fit on the screen. Responses involving the increasing distortion or blurring of the shadow for smaller distances were quite acceptable. Although not suggested in the question, it would have been sensible for candidates to have tried the experiment at a smaller distance and it seemed probable from their answers that a number had done this.

PHYSICS

Paper 0625/61
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 on 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.

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
- tabulation of readings
- graph plotting and interpretation
- manipulation of data to obtain results
- drawing conclusions
- understanding of the concept of results being equal within the limits of experimental accuracy
- dealing with possible sources or inaccuracy
- control of variables
- choosing the most effective way to use the equipment provided.

It is assumed that, as far as is possible, the IGCSE course will be taught so that candidates undertake regular practical work as an integral part of their study of physics. This examination should not be seen as suggesting that the course can be fully and effectively taught without regular practical work.

Clearly, some of the skills involved in practical work can be practised without doing experiments. These include graph plotting and tabulation of readings. However, there are parts of this examination in which the candidates are effectively being asked to answer from their own practical experience. Questions on experimental techniques were answered much more effectively by candidates whose answers demonstrated that they had had experience of similar practical work and much less successfully by those who, apparently, had not. Many candidates will have prepared for the examination, very sensibly, by working through some past papers. However if this was done with little understanding, candidates gave answers that would have been correct in a similar question from a previous session, but were not appropriate to this question paper.

Some candidates have clearly had access to the mark schemes from past papers. It should be realised that these are written primarily for Examiners. Answers such as, 'Statement to match readings' or 'Justified by reference to the readings' show learning of mark scheme instructions rather than understanding of the questions.

Comments on Specific Questions

Question 1

(a) Most candidates successfully measured the length in millimetres.

(b) Most candidates successfully calculated the actual length, multiplying by 10. Some divided by 10 and others wrote numbers that seemed unrelated. Candidates were expected to give the value of *k* to two or three significant figures, which is appropriate in terms of the precision of their measurement and the data given for *F*. This part also gave an opportunity for candidates to show their understanding of units. Most candidates either gave a correct unit or no unit.

(c) Most candidates calculated *T* correctly.

(d) Here candidates were asked to think carefully about the experiment and make a judgement on the results. A significant number of candidates assumed that the results would support the suggestion and justified this by claiming that the results were within the limits of experiment accuracy. Successful candidates, however, realised that the results did not support the suggestion and were able justify their statement with reference to the results, for example by stating 'the difference is too large to be explained by experimental inaccuracies'). Unfortunately many who made a correct statement did not justify it but merely quoted the results without further explanation.

(e) Many candidates gained credit by clearly showing on a diagram the importance of viewing the scale perpendicularly.

Question 2

This question required candidates to consider an experiment that they may not have seen before but to use their knowledge and experience of other experiments to make sensible suggestions.

(a) Candidates suggested a range of improbable instruments here but a good proportion correctly suggested a suitable timing device such as a stopwatch.

(b) It was pleasing to see many candidates approaching this thoughtfully and many made at least two correct suggestions.

(c) Some candidates did little more than repeat the question here. To obtain full credit candidates needed to comment on the fact that the temperature would probably be too high for the thermometer and that it would not be possible to surround the thermometer bulb with the metal.

Question 3

(a) Most candidates successfully recorded the temperature.

(b) Most candidates correctly recorded the units (s, °C, °C). The majority of candidates realised from the table that the rate of cooling decreased with the insulation. To score full credit, candidates needed to illustrate this by reference to the results, for example by showing a suitable pair of temperatures drops.

(c) Here candidates had the opportunity to show their understanding of the control of variables and needed to carefully select two possibilities. The Examiners looked for sensible comments relating to room temperature, starting temperature or the amount of cotton wool.

Question 4

(a) Many candidates were able to read the meters correctly. The knowledge of units was usually good and most candidates successfully calculated the resistance.

(b) Many candidates realised that the brightness would increase but some wrote about the resistance and so did not answer the question asked.

(c) It was pleasing to see that many candidates thoughtfully wrote about the difficulty in placing the sliding contact in exactly the same position. Other sensible answers were also credited.

(d) Candidates who understood how to interpret the data represented by the graph line were able to comment that the line showed an increase in resistance and to explain the reason for their answer. Less confident candidates could only make a comment on the reason that was too vague to score.

Question 5

(a)(b) Many candidates drew a neat, accurate ray-trace, following the instructions with attention to the details. The candidates are expected to use a sharp pencil, ruler and protractor with care to demonstrate their practical skill.

(c) Many candidates were able to label the graph axes correctly and choose a scale that made good use of the grid. Plotting was generally accurate, but a significant number of candidates did not gain the credit available for the scale, choosing a scale that was too small, often using a scale based on multiples of three. Some candidates did not gain credit for the graph line, usually by drawing a ‘dot-to-dot’ line rather than a best-fit line.

(d) Candidates should have drawn a large triangle (using at least half of their graph line) in order to determine the gradient. To gain full credit, candidates needed to obtain a gradient value within the tolerance allowed.

(e) Here candidates were asked to think carefully about the experiment and make a judgement on the results. From their experience during the course they should have been able to see that the conclusion being looked for here is that $\alpha - \alpha_o = 2\theta$.

(f) Some candidates made a sensible suggestion relating to the placing of the pins, for example ‘place the pins as far apart as possible’, ‘view the bases of the pins’ or ‘make sure the pins are vertical’. Some had apparently learned responses from mark schemes and made suggestions unrelated to this experiment such as ‘use a darkened room’ – a response that would be suitable for a lens experiment with an illuminated object.

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 on 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.

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 of readings
- graph plotting and interpretation
- manipulating data to obtain results
- drawing conclusions
- understanding the concept of results being equal to 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 it was pleasing to see that the range of practical skills being tested proved to be accessible to most of the candidature. Most candidates demonstrated that they were able to draw upon their own personal practical experience to answer the questions. No parts of any question proved to be inaccessible to candidates and there was no 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 invariably included, writing was legible and ideas were expressed logically. However, candidates seemed less able to derive conclusions from given experimental data and justify them.

All questions provided opportunities for differentiation, but particularly good were **Questions 1 (c)(iii)**, **2 (c)**, **3(d)** and **5(b)**. The ability to record readings to an appropriate precision, usually reflecting the measuring instrument used, or to quote a derived result to an appropriate of significant figures, still causes difficulty for many candidates.

The vast majority of candidates finished the paper and there were few scripts with substantial numbers of no responses to the question set. There were some scripts which showed an exemplary understanding of practical skills but equally, there were 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.

Question 1

(a) Very few candidates did not score both marks here. The lengths were measured accurately, but sometimes quoted unrealistically to two decimal places – no penalty was applied for doing this in this part of the question.

(b) Most candidates described wrapping one single loop of string around the pencil in order to determine its circumference, and so did not gain full credit. A significant number of candidates mentioned wrapping the whole of a measured length of string around the pencil, without concern that this might produce a fractional turn at the end. This is poor experimental technique, and was not credited. A minority of candidates dispensed with the string completely and suggested measuring the diameter of the pencil with the rule, and then calculating the circumference. However, it must be said that there were some very good, clear explanations which gave good practical detail and precautions.

(c) (i) Too many candidates referred to inaccurate rulers or human error in suggesting a source of inaccuracy in determining the circumference. The most popular correct answers were that the thickness of the string had not been taken into account or that there might be gaps between the windings.

(ii) Most candidates succeeded with the calculation of the volume of the unsharpened section of the pencil, but many were then penalised by omitting the unit. Where a unit is not given on the answer line, candidates are required to supply one if appropriate.

(iii) This more challenging final part produced some good, well-reasoned answers. The better candidates approximated the sharpened end to a cone and used an appropriate formula. Any sensible estimate was accepted, as long as candidates showed that the volume of the sharpened end was less than that of a cylinder of the same length. A number of candidates produced a volume estimate for the sharpened end which was larger than the volume of the unsharpened end, and made no comment that this could not possibly be so.

Question 2

(a) The temperature reading displayed by the thermometer was usually correctly read. Occasionally the unit of temperature was incorrect or omitted.

(b) Most candidates had good labelling, accurate plotting and a thin line of acceptable quality. Candidates who decided to include the origin on the temperature axis produced graphs which were too small and did not make best use of the grid supplied. Drawing the line of best fit caused most problems in this question. Good, smooth best fit curves through the data points were produced by less than half the candidates. Too many candidates joined the first point to the last, whilst others treated the first point as anomalous, and drew a best-fit straight line through the remainder, especially those candidates who had cramped the temperature axis.

(c) (i) When asked to describe the shape of the best-fit graph that they had drawn, many candidates who had incorrectly drawn straight lines of best fit, then went on to say that the graph was curved.

(ii) The more able candidates described the curves that they had drawn correctly, and stated that the rate of cooling of the water decreased with increasing time. Many of those candidates who had drawn a straight line graph in **(b)**, went on to describe the rate of cooling changing as if it were a curve, demonstrating a misunderstanding of the use of a best-fit line as a representation of the trend in the data.

(d) Most candidates gained this mark by drawing a diagram showing the reading being taken with the eye level with the water level and a line to show that the line of sight was perpendicular to the cylinder. Candidates who did not draw a diagram and attempted to explain how to avoid parallax, got into all sorts of problems, with words such as parallel/perpendicular/horizontal/vertical to the water level appearing in their answers. Many candidates knew about the meniscus, and scored the mark either by using a diagram, or by stating that the reading is taken to the bottom of the meniscus.

Question 3

(a) The meter readings were usually written down correctly. Where errors occurred, the most common incorrect answers were 2.05 or 2.2 V and 0.425 or 0.44 A. The value of the resistance was usually calculated correctly from the voltmeter and ammeter readings, but rounding errors or missing units were not uncommon.

(b) Some candidates did not appreciate that the starting position of the sliding contact in **(a)** was **X**. Instead, they described the change as though starting from the position shown in the diagram and stated incorrectly that the current would first increase, and then decrease.

(c) Most candidates were able to draw a recognisable standard circuit symbol for a variable resistor. Common errors included thermistors, potentiometers, variable fuses, and even the old symbol of an arrow passing through a zigzag of wire. Circuit symbols used on IGCSE Physics papers are given at the back of the syllabus.

(d) The majority of candidates knew how to take two points from the graph or to draw a triangle to calculate the gradient. Candidates did not always state or draw on the given diagram to show that the points should be far apart, or that the triangle needed to be big. A minority of candidates inverted the division, whereas some even tried to find the area of the triangle. Some candidates used just one point and incorrectly stated that the gradient was the ratio of the *y* and *x* coordinates of the point.

Question 4

(a) (i) This part was mostly done well, although some candidates were penalised because of careless drawing and making their arrows imprecise. Many candidates may have intended to use a common left-hand arrow for both distances, but unfortunately in many cases it was not indicated clearly and looked as if the distance *y* started at the left-hand lens. Other common errors were marking the distances to the outside of the lens, marking one of the distances from the screen and measuring from the lamp and not the illuminated object.

(ii)(iii) These calculations were almost always invariably correct.

(iv) Although the calculation caused few problems, many candidates lost some credit due to incorrect rounding, use of excessive significant figures or the omission of a unit.

(b) Many candidates gained full credit for two sensible precautions. The use of a dark room and taking an average from repeated measurements were the two most common correct answers. Some candidates missed the point of the question and referred to ‘measuring carefully’ or other references to technique which should be expected, anyway, if an experiment is carried out with reasonable care.

(c) Few candidates were given full credit for this part because candidates tended to contradict themselves, or to give a long list of differences and similarities between the images, where a correct response was followed directly by an incorrect response. It was not uncommon in **(i)** for candidates to state that one image was enlarged and the other image was diminished, and then in **(ii)** to state that the images were the same size. Very few candidates were able to use their practical experience to realise that there would be a difference in the brightness of the images.

(d) Many candidates suggested correctly that the variable that could be changed was *D*. A popular incorrect response was the lens to object distance.

Question 5

(a) Although the more able candidates were able to make sensible estimates of the length of the slope and its height above the laboratory bench, many of the candidates simply measured the distances from the diagram. It was also not uncommon to see an estimate for the height *h* being bigger than the length l of the slope.

(b) Only a very small number of candidates gained all of the available credit, probably drawing on their own practical experience of carrying out similar experiments involving the timing of moving objects. Common correct responses were repeating the experiment and using automatic timers or light gates. Some candidates gave responses which did not answer the question posed in the stem.

PHYSICS

Paper 0625/63
Alternative to Practical

Key Messages

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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.

General comments

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

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- manipulation of data to obtain results
- drawing conclusions
- understanding of the concept of results being equal within the limits of experimental accuracy
- dealing with possible sources or inaccuracy
- control of variables
- choosing the most effective way to use the equipment provided.

As far as possible, the IGCSE course should be taught so that candidates undertake regular practical work as an integral part of their study of physics. This examination should not be seen as suggesting that the course can be fully and effectively taught without practical work. Some of the skills involved in experimental work, including graph plotting and tabulation of readings, can be practised without doing experiments. However, there are parts of this examination in which the candidates are asked to answer from their own practical experience. Questions on experimental techniques were answered much more effectively by candidates whose answers demonstrated that they had had experience of similar practical work and much less successfully by those who, apparently, had not.

The practical nature of the examination should be borne in mind when explanations or justifications are asked for. This was seen in some of the straightforward responses to **Question 2(e)**, referring to results rather than theory, and in the clear practical details given by some candidates in **Question 3(d)**.

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 **Questions 1** and **5(a)**.

The relationship between the variables plotted in **Question 5** indicated a clear curve. Many candidates recognised this possibility while others attempted to fit straight lines to plotted points which did not justify them.

Comments on specific questions

Question 1

Good responses to this question were seen from many candidates, although the later sections involving practical considerations proved challenging for some.

(a) The majority of candidates recorded the masses correctly although a few included the colon from the diagram of the balance rather than the required decimal point. The volume was generally recorded accurately, values of 66 cm^3 being occasionally seen. As units for the mass and volume were given in the question, it was expected that the density would be expressed in g / cm^3. This was generally the case, with Pa or omission of the unit being the most common errors.

Credit was given to candidates who converted correctly to kg / m^3 but this was rarely seen.

(b) Most candidates recorded the appropriate mass, use of a colon being allowed if it had already been penalised in part **(a)**. The volume was generally read correctly, although 84 cm^3 was seen on occasions, and the difference in volume was almost always calculated accurately. Density was often expressed to the expected 2 or 3 significant figures, as was appropriate from the volume measurements used in the calculation.

(c) While the average value of density was calculated correctly by the majority, use of ($\rho_1 + \rho_2$) or (ρ_1 / ρ_2) was seen.

(d) This question called for candidates to focus on the reading of the volume as shown in part **(a)**. Many good answers, including diagrams, described the line of sight needing to be perpendicular to the reading, taken from the bottom of the meniscus. Either point was given credit. Answers involving the use of different measuring cylinders with more precise graduations were not acceptable.

(e) Many candidates found this question challenging. Although a number suggested a possible source of inaccuracy, few were able to correctly state and explain the effect on the value of density obtained. The most straightforward correct answers, both resulting in a larger value for density, identified that the balance may not be set to zero, producing a larger value of mass, or that friction between the test-tube and cylinder may result in a smaller displaced volume of water. While it is recognised that this would have a minimal effect, credit was given to those candidates who stated that some of the mass of the cotton was supported by the edge of the cylinder rather than contributing to displacement of water.

Question 2

This question was well done by many candidates.

(a)(b) The thermometer readings were recorded correctly by the majority of candidates. Very occasionally, values of 82 °C and 80.9 °C were seen.

(c) It was usual to see the units expressed correctly, although they were occasionally left blank. Where the column *t* values were inserted, 0 was often correctly included.

(d) The clearest pattern of temperature change applying to both beaker **A** and beaker **B** was that the rate of temperature decrease at the start of the experiment was greater than at the end. A number of candidates identified this but many described more complicated patterns, few of which applied to both beakers or were consistent throughout the experiment. Some candidates chose the fact that both beakers had a temperature of 83 °C after 60s. This, however, was not a pattern of temperature <u>change</u> and was not accepted.

(e) Some good simple answers were seen, in support of the suggestion, pointing out that the temperature change in beaker **A**, with the larger volume of water, was 9.5 °C compared to 15 °C for beaker **B** in the same time interval. Others calculated and compared the average rate of temperature change over 180 s. A number of candidates omitted the reference to any time interval and did not gain full credit. It should be noted that the lower final temperature of beaker **B** was not accepted as sufficient evidence if the starting temperatures were not included in the justification, as the beakers did not start off at the same temperature.

(f) Good responses to this question were generally seen, with 'initial temperature of hot water' and 'room temperature' being common correct answers. Correct references to the dimensions of the beaker, the depth of the thermometer bulb and the volume of water were frequently seen.

Question 3

This was the question that many candidates were able to answer most successfully.

(a) There were many correct meter readings, although 2.9 (V) and 0.85 (A) were seen on occasions.

(b) Correct units for V and I were usually given. Some candidates omitted the answers, possibly through not having read the question fully, and others gave the quantity, i.e. 'voltage', 'current', rather than the unit.

(c) The values of resistance were often determined accurately and included a correct unit. Significant figures were not being tested in this particular question but there were some obvious rounding errors. Typically 0.996 was rounded to 0.99 rather than 1.00 for R_C, and 1.954 was rounded to 1.96 rather than 1.95 for R_B. It was clear in the latter case that some candidates had incorrectly rounded twice after their calculation, from 1.9548 to 1.955 and subsequently to 1.96.

Many correct answers agreeing with the suggestion were seen, the justification being given that the difference between R_A and (R_B + R_C) was within the limits of experimental accuracy. A number of candidates reasonably quoted 10% as their expected limit but others disagreed with the suggestion because the two values were not exactly the same.

(d) This question required candidates to consider precautions which could be taken in this type of experimental work, based on their own practical experience. Straightforward techniques of using smaller potential differences and currents or switching off between readings were given credit, although only a minority of candidates gave such responses. Candidates should be aware that using wires with a larger cross-sectional area, a common incorrect answer, would have the effect of increasing the temperature rise rather than reducing it.

Question 4

Some good responses were seen to this question but a significant number of candidates found the diagram to be challenging.

(a) A simple circuit, with the power supply, variable resistor, ammeter and electromagnet connected in series was expected here and some good, clear diagrams were seen. A common error was to draw a thermistor symbol or a plain diagonal line rather than a diagonal arrow through the rectangle of the variable resistor. A number of candidates showed a parallel ammeter connection or connected the terminals of the electromagnet together.

(b) The majority of candidates calculated the values of M correctly, using the number of decimal places indicated by the data in the rest of the column.

Many recognised that the results suggested a proportional relationship between M and I but fewer candidates were able to justify their statements adequately. However, some clear, rigorous answers were given, explaining that the results all satisfied the conditions required for such a relationship and showing that the constant of proportionality between M and I was 4.12.

Question 5

This was the question that was least well done by many candidates with the explanations and the curved line of the graph being found particularly challenging.

(a) Many candidates recorded appropriate measurements, with the expected 2 significant figures. Some rounding errors in the s value were seen.

A number of candidates missed the evidence later in the table that the measurements of w and h might not always be the same, despite the object being square. However, some correctly pointed out that the blurred edges of the shadow, shown in Fig. 5.2, could make measurements difficult and that taking an average value would improve reliability. Candidates should be made aware that clues to a correct response can often be found in the question.

(b) Some good graphical skills were seen, with clearly labelled axes, appropriate scales which allowed the plotted points to occupy at least half of the grid and accurate plots shown with fine crosses. The advice is that plotted points should, preferably, be marked with small fine crosses. Small dots are acceptable but are often obscured when the line is drawn through them, making it more difficult to award the mark for correctly plotted values. The large dots used by a significant 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.

Although correctly plotted points clearly indicated it, only a minority of candidates were able to produce a smooth well-judged curve. Many drew a straight line or used smaller straight lines to join the plots together. Many physical quantities have a relationship which will produce a curved line on a graph and candidates should be prepared for this.

(c) It was expected that candidates would take into account the increasingly large differences between successive values of *s* and recognise the need for an intermediate point so that better line judgement could be achieved. Only a minority of candidates explained this adequately. The common response that ‘more plots produce a more accurate line’ did not sufficiently address the need for the intermediate point to be here rather than between other values on the *d* axis.

(d) Many candidates successfully matched the values given in Table 5.1 and Fig. 5.1 and recognised that a shadow for distances of less than 15 cm between the lamp and the object would probably be too large to fit on the screen. Responses involving the increasing distortion of the shadow for smaller distances were quite acceptable.