PHYSICS

Paper 0625/11
Multiple Choice

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

General Comments

Candidates performed best on **Questions 5** and **17**, with **Questions 22** and **32** being the most challenging.

Comments on Specific Questions

Question 4

Many weaker candidates confused mass with weight, believing that mass would be less on the Moon than on Earth.

Question 8

Although able candidates scored very highly in this question on work, weaker candidates believed that the time for which a force acts was required to calculate work, possibly confusing it with power.

Question 14

The topic for this question was thermal expansion, and almost half the responses were incorrect. Candidates were required to link the increased volume of the heated disc to decreased density, and this proved difficult for many.

Question 18

A large majority of candidates were aware that wavelength, rather than frequency, could be measured from the diagram shown, but some believed the wave to be longitudinal.

Question 22

In this question on refraction a large number of candidates chose option **B**, being unaware that some light is reflected internally even if the angle of incidence in the glass is less than the critical angle; the syllabus refers to ‘internal and total internal reflection’.

Question 32

Considerably more candidates were familiar with the effect of light on the resistance of a LDR than understood the operation of a potential divider circuit.

PHYSICS

Paper 0625/12
Multiple Choice

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

General Comments

Candidates found **Questions 5** and **17** the easiest on this paper, with **Questions 22** and **32** being the most challenging.

Comments on Specific Questions

Question 4

Many weaker candidates confused mass with weight, believing that mass would be less on the Moon than on Earth.

Question 8

Although able candidates scored very highly in this question on work, a large number of candidates believed that the time for which a force acts was required to calculate work, presumably confusing it with power.

Question 14

The topic for this question was thermal expansion, and almost half the responses were incorrect. Candidates were required to link the increased volume of the heated disc to decreased density, and this caused difficulty for many.

Question 18

A large majority of candidates were aware that wavelength, rather than frequency, could be measured from the diagram shown, but some believed the wave to be longitudinal.

Question 22

In this question on refraction a large number of candidates chose **B**, being unaware that some light is reflected internally even if the angle of incidence in the glass is less than the critical angle; the syllabus refers to “internal and total internal reflection”.

Question 32

Considerably more candidates were familiar with the effect of light on the resistance of a LDR than understood the operation of a potential divider circuit.

PHYSICS

Paper 0625/13
Multiple Choice

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

General Comments

Questions **3**, **4**, **8**, **10** and **12** were answered best on this paper, with no questions proving particularly challenging.

Comments on Specific Questions

Question 5

This question was well answered, but the most common mistake was to divide the mass of the metal by the original volume of water in the measuring cylinder, leading to option **C** as the answer.

Question 7

This was well answered, but many candidates incorrectly chose position **C** as the possible centre of mass. Although this was approximately half way between the man and the truck, it was to the right of the right wheel of the truck.

Question 11

The relatively small number of candidates who chose incorrectly in this question on water pressure failed to use the information given that density decreases with temperature increase, or failed to link this density decrease to pressure decrease.

Question 14

The topic for this question was thermal expansion, and slightly more than a quarter of the responses were incorrect. Candidates were required to link the increased volume of the heated disc to decreased density, and this caused difficulty for some.

Question 15

Just over half of responses were correct in this thermometer question. Option **A** was a popular choice for weaker candidates; these candidates failed to add the original length to the increase in length from 0 °C to 50 °C.

Question 16

Only 40% of candidates answered this correctly, apparently being unfamiliar with the process of convection and/or the fact that air is an insulator; all the incorrect options were popular.

Question 18

Quite a large proportion of weaker candidates were unfamiliar with the nature of longitudinal and transverse waves, or an example of each.

Question 22

Here more than half the candidates were confused over the meaning of critical angle and the fact that total internal reflection only occurs when light travelling in a more dense substance meets the boundary with a less dense one.

Question 23

Weaker candidates made the mistake of forgetting to divide the distance travelled by the sound by two to find the depth of the sea.

Question 32

Potential divider questions are often more challenging for weaker candidates. In this case, just over a half of responses were correct, with option **B** being the most popular incorrect choice.

PHYSICS

Paper 0625/21

Core Theory

Key Messages

Apart from being well prepared to answer questions from across the Core syllabus there are further aspects of examination preparation that could have helped some candidates improve their performance.

- Candidates should note the number of marks available and the space allocated for responses as these factors provide a clear indication of the type of answer that is expected. For example, on a two mark question, two distinct points will be expected.
- Candidates must read the question carefully and make sure they follow the instructions in the question.
- Candidates are advised to read through their responses carefully to make sure that what they have written has the intended sense. Concise explanations are often the best.
- In calculations, candidates must set out and explain their working correctly. There may be credit awarded for working if the final answer is correct, due to the merit of the work. However, when a candidate makes an error and no working is shown, it is often impossible for any credit to be awarded for the question.

General Comments

A high proportion of candidates were clearly well prepared for this paper. There remains the tendency to think less rigorously and logically in non-numerical questions than in numerical questions. Some areas of the syllabus were better known than others; in particular evaporation, the fixed points of a temperature scale and the advantages of transmitting electricity at high voltages were not well understood.

Equations were generally well known by all, but the weakest candidates. Many candidates understood well how to apply equations to fairly standard situations. On occasions, however, when asked to apply their knowledge to a new situation, they displayed a lack of breadth of understanding of the use of the equation. More practice in applying equations in unfamiliar situations would deepen candidates' understanding and improve their performance in the examination.

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.

Candidates did not seem to find any difficulty in completing the paper in the allocated time and overall, relatively few left answers to questions blank.

Comments on Specific Questions

Question 1

(a) (i) The majority of candidates correctly named the measuring cylinder. Weaker candidates used terms such as test-tube or cylinder.

(ii) Most candidates recognised that some form of balance was needed. A significant number of weaker candidates left this blank.

(b) Most candidates identified the correct statements about the densities of the liquids. A small minority of candidates ticked more than two boxes, and consequently lost marks.

(c) Only more able candidates gained full credit. Common mistakes were to invert the density equation or to omit a correct unit.

Question 2

(a) (i) A surprising number of candidates failed to calculate the correct time.

(ii) With error carried forward, the majority of candidates gained full credit. Weaker candidates used incorrect expressions for average speed.

(iii) This was answered correctly by the majority of candidates.

(b) Most candidates gave reasonable estimates and sensible explanations about the car's average speed. A significant number of weaker candidates left this blank.

Question 3

(a) The vast majority of candidates linked the correct diagram to the states of matter.

(b) (i) Only more able candidates gained full credit. Weaker candidates merely restated the question in their answer.

(ii) Stronger candidates performed well here. Many candidates failed to link statements about particles to give a reasoned suggestion.

Question 4

(a) Many candidates gave two differences between microwaves and sound waves. Weaker candidates often gave the converse of their first response, and so could not be given full credit.

(b)(i),(ii) The majority of candidates identified reflection and diffraction.

Question 5

(a) This question proved challenging for a number of candidates. The majority of candidates thought that the upper fixed point was 110 °C and the lower fixed point was –10 °C.

(b) Very few candidates gave valid descriptions for cooling a thermometer to its lower fixed point. A very common error was to suggest putting the thermometer in a freezer.

(c) The majority of candidates identified the correct physical property. The most common mistake was to select colour as the physical property used to measure temperature in a liquid-in-glass thermometer.

Question 6

(a) This was answered correctly by the majority of candidates.

(b) A significant number of candidates left this question blank. Many candidates seemed unfamiliar with energy transfer diagrams.

(c) (i) The majority of candidates gained some credit for answers to this question.

(ii) Only the more able candidates suggested using a rechargeable battery. Incorrect responses ranged from using geothermal energy to nuclear energy.

(d) This was answered correctly by the majority of candidates.

Question 7

(a) The majority of candidates gained some credit for this question. The most common mistake was to have the arrows in B and D pointing toward the centre of the magnet rather than to the S-pole.

(b) This question was understood and answered correctly by most candidates.

(c) While a majority of candidates answered corrected, the most common incorrect answer given was iron.

Question 8

(a) (i) The operation of a relay seems poorly understood by many candidates with only a small minority gaining full credit for this question.

(ii) Few candidates did this question well with many candidates failing to link the need for a low resistance to reduce heating in the cable.

(b) (i) The majority of candidates understood the requirements of this question. A common error was to state that the current was twice that in the fuse.

(ii) Many candidates gave a valid reason for connecting the lights in parallel.

Question 9

(a) (i) Most candidates clearly identified the thermistor. However, a significant number of candidates thought that the variable resistor was a thermistor.

(ii) The vast majority of candidates drew a correct symbol for a voltmeter, but many of these were connected in series with the thermistor.

(b) (i) Many candidates struggled with this calculation, failing to use the table to determine the current in the thermistor, and attempting to divide the potential difference across the thermistor by 20 (°C). Many others used incorrect rearrangements of $V = IR$.

(ii) The vast majority of candidates gave very clear and accurate explanations.

Question 10

(a) The majority of candidates gained full or partial credit for this question.

(b) This question was generally done well and candidates were clearly well rehearsed in drawing ray diagrams for thin lenses. Only the weakest candidates failed to gain any credit.

Question 11

(a) Most candidates completed this correctly. The most common error was to select alpha radiation as having the greatest speed.

(b) (i) The majority of candidates gained some credit here.

(ii) The vast majority of candidates gained full credit for this question.

(iii) Many candidates correctly identified the emitted particle as an alpha particle. A common mistake by weaker candidates was to state that it was an electron.

Question 12

(a) (i) The majority of candidates were able to identify the turbine.

(ii) Most candidates were able to give two distinct disadvantages although some weaker candidates often repeated the same disadvantage or gave a response in such general terms that it was not creditworthy, e.g. pollution.

(b) Only weaker candidates failed to gain any credit on this question. The most common error was incorrect rearrangements of the transformer equation.

(c) A small minority of candidates answered this question correctly. The advantages of transmitting electricity at high voltages proved challenging for the vast majority of candidates.

PHYSICS

Paper 0625/22
Core Theory

Key Messages

- Candidates are reminded to read questions carefully and identify the information that addresses the question in order to gain full credit. In a number of cases candidates are providing information associated with a section of the syllabus, but are not applying the information to the question that has been asked.
- Candidates should be encouraged to demonstrate their understanding of the application of physics and give concise answers in line with the number of marks allocated and the space made available for responses. For example, a one-mark question with one line allocated requires a short response, often involving a key term or phrase.
- It should be noted that candidates are not penalised for giving incorrect responses; candidates are therefore advised to attempt all questions.
- Candidates are advised to give concise responses, duplication of information that includes ambiguity cannot secure full credit.
- When completing calculations candidates should set out and explain the stages in their working clearly. Candidates can often gain partial credit when clear working out is shown even if the final answer is incorrect. Candidates who give only the answer risk gaining no credit for the question if their answer is incorrect.
- All candidates should be advised to check through their responses. Errors such as failing to answer part of a question, the omission of a unit or checking that the appropriate number of ticks has been used in a tick box question can then be avoided.

General Comments

A high proportion of candidates performed well on this paper indicating that many candidates had a good understanding of the syllabus. Some areas of the syllabus were better known than others, however. The questions on the bimetallic strip and determining the magnetic field using a pivoted magnet proved to be challenging for all but the strongest candidates. A small number of the very best candidates may have benefitted from being prepared and entered for the Extended Theory paper.

All but the weakest candidates were able to use and apply standard equations such as distance divided by time gives speed. A significant proportion candidates were unable to correctly determine the average thickness of the folded wire in **Question 1 (b)(ii).** Candidates of all levels of achievement were unsure how to calibrate a bimetallic strip to measure temperatures.

The English language ability of most of the candidates was appropriate for the demands of this paper; very few were unable to express themselves adequately. In a very small number of cases credit could not be given for responses that were illegible.

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

Comments on Specific Questions

Question 1

(a) This question was answered well by most candidates.

(b) (i) This question was answered well by most candidates. Values ranging between 0.60 and 0.75 were seen.

(ii) Surprisingly, this was not a well-answered question. A common incorrect response was for candidates to multiply the answer in **(b)(i)** by 10 or to convert cm into mm by multiplying by 100. A number of candidates responded with an incorrect value without showing their working and could not be given any credit. Weaker candidates also gave responses with more than two significant figures.

Question 2

(a) (i) This question was answered well by almost all candidates.

(ii) Only the very weakest candidates failed to gain full credit for this question.

(iii) Most Candidate answered this question correctly. A common incorrect response was 4 seconds.

(b) (i) Most candidates gave accurate responses to this question.

(ii) This question was well answered by only the better prepared candidates.

(iii) This question was not well answered. A common misconception was that the bicycle would move backwards.

Question 3

(a) This question was answered well by most candidates.

(b) There were correct responses from only stronger candidates.

(c) Most candidates gained full credit for this question.

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

Question 4

(a) (i) This question was answered well by most candidates.

(ii) Although there were many correct responses, a common incorrect answer was chemical energy.

(iii) Full credit was gained by only the better prepared candidates. Many candidates gained partial credit. A common incorrect answer was electrical energy.

(iv) This question was answered correctly by the majority of candidates. A common error was to choose ‘more reliable’.

(b) Better candidates gained at least partial credit for this question.

Question 5

(a) This question was answered correctly by better prepared candidates.

(b) (i) This question proved to be challenging to all candidates. Few candidates recognised the need to calibrate the bimetallic strip. A small number of candidates did gain credit for recognising at least one of the fixed points.

(ii) This question was not answered well. There were many vague responses to this question that were not worthy of credit.

Question 6

(a) (i) This question was generally answered correctly.

(ii) Although there were many correct responses, a common incorrect answer was boiling.

(b) Most candidates gained at least partial, if not full credit for this question. Weaker candidates gained some credit for recognising that hot water rises and/or cold water falls. A few candidates gave incorrect responses in terms of heat rising. A small number of candidates gave incorrect responses in terms of evaporation of water.

Question 7

(a) (i) There were good answers to this question from stronger candidates.

(ii) A majority of candidates answered this question correctly.

(b) This question was answered well by better prepared candidates.

Question 8

(a) The ray diagram was drawn well by only the better prepared candidates. Many candidates were able to identify the principal focus. Some candidates could not be credited for rays that were not accurately positioned or were drawn using very thick lines. There were also errors in showing refraction. Credit was given for refraction at the centre of the lens or for showing refraction on entry and exit from the lens.

(b) Most candidates gained credit for their response to this question. However, some candidates gave contradictory responses such as 'enlarged and diminished' or 'inverted and upright' preventing them from gaining full credit.

Question 9

(a) This question was not well answered. There were a number of candidates that gave no response to this question.

(b) (i) A correct response was usually given by stronger candidates. A common incorrect response was resistor or variable resistor.

(ii) A number of candidates obtained full credit for this question.

Question 10

(a) (i) Many partially correct responses were seen. The majority of candidates gained credit for recognising repulsion, but indicated that this was due to charges rather than magnetic poles.

(ii) Most candidates gave correct responses to this question. Iron and copper were common incorrect responses.

(b) This question proved challenging with only the best prepared candidates able to give credit-worthy responses.

Question 11

(a) For this question only the better prepared candidates gained full credit. A common misconception was that the heater was on when switch S was open and switch T was closed.

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

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

(d) (i) The majority of candidates knew the symbol for a fuse and were able to place it in the circuit correctly.

(ii) The better prepared candidates completed this question fully. Many candidates, however, gained partial credit. A common incorrect answer was that the hairdryer would be damaged.

Question 12

(a) Very few candidates completed the table correctly, but many candidates gained some credit for stating that an electron had a negative charge.

(b) (i) Higher scoring candidates gained partial credit for recognising that alpha particles produced more ions. There were many vague responses about the ability of beta particles and gamma rays to penetrate materials, but few candidates indicated that alpha particles would be stopped by smoke particles. A misconception stated by some candidates was that alpha was used for safety reasons.

(ii) This question proved challenging with very few correct responses.

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

PHYSICS

Paper 0625/23
Core Theory

Key Messages

Apart from being well prepared to answer questions from across the Core syllabus there are further aspects of examination preparation that could have helped some candidates improve their performance.

- Candidates should note the number of marks available and the space allocated for responses as these factors provide a clear indication of the type of answer that is expected. For example, on a two mark question, two distinct points will be expected.
- Candidates must read the question carefully and make sure they follow the instructions in the question.
- Candidates are advised to read through their responses carefully to make sure that what they have written has the intended sense. Concise explanations are often the best.
- In calculations, candidates must set out and explain their working correctly. There may be credit awarded for working if the final answer is correct, due to the merit of the work. However, when a candidate makes an error and no working is shown, it is often impossible for any credit to be awarded for the question.

General Comments

A high proportion of candidates were clearly well prepared for this paper. There remains the tendency to think less rigorously and logically in non-numerical questions than in numerical questions. Some areas of the syllabus were better known than others; in particular evaporation, the fixed points of a temperature scale and the advantages of transmitting electricity at high voltages were not well understood.

Equations were generally well known by all, but the weakest candidates. Many candidates understood well how to apply equations to fairly standard situations. On occasions, however, when asked to apply their knowledge to a new situation, they displayed a lack of breadth of understanding of the use of the equation. More practice in applying equations in unfamiliar situations would deepen candidates' understanding and improve their performance in the examination.

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.

Candidates did not seem to find any difficulty in completing the paper in the allocated time and overall, relatively few left answers to questions blank.

Comments on Specific Questions

Question 1

(a) (i) The majority of candidates correctly named the measuring cylinder. Weaker candidates used terms such as test-tube or cylinder.

(ii) Most candidates recognised that some form of balance was needed. A significant number of weaker candidates left this blank.

(b) Most candidates identified the correct statements about the densities of the liquids. A small minority of candidates ticked more than two boxes, and consequently lost marks.

(c) Only more able candidates gained full credit. Common mistakes were to invert the density equation or to omit a correct unit.

Question 2

(a) (i) A surprising number of candidates failed to calculate the correct time.

(ii) With error carried forward, the majority of candidates gained full credit. Weaker candidates used incorrect expressions for average speed.

(iii) This was answered correctly by the majority of candidates.

(b) Most candidates gave reasonable estimates and sensible explanations about the car's average speed. A significant number of weaker candidates left this blank.

Question 3

(a) The vast majority of candidates linked the correct diagram to the states of matter.

(b) (i) Only more able candidates gained full credit. Weaker candidates merely restated the question in their answer.

(ii) Stronger candidates performed well here. Many candidates failed to link statements about particles to give a reasoned suggestion.

Question 4

(a) Many candidates gave two differences between microwaves and sound waves. Weaker candidates often gave the converse of their first response, and so could not be given full credit.

(b)(i),(ii) The majority of candidates identified reflection and diffraction.

Question 5

(a) This question proved challenging for a number of candidates. The majority of candidates thought that the upper fixed point was 110 °C and the lower fixed point was –10 °C.

(b) Very few candidates gave valid descriptions for cooling a thermometer to its lower fixed point. A very common error was to suggest putting the thermometer in a freezer.

(c) The majority of candidates identified the correct physical property. The most common mistake was to select colour as the physical property used to measure temperature in a liquid-in-glass thermometer.

Question 6

(a) This was answered correctly by the majority of candidates.

(b) A significant number of candidates left this question blank. Many candidates seemed unfamiliar with energy transfer diagrams.

(c) (i) The majority of candidates gained some credit for answers to this question.

(ii) Only the more able candidates suggested using a rechargeable battery. Incorrect responses ranged from using geothermal energy to nuclear energy.

(d) This was answered correctly by the majority of candidates.

Question 7

(a) The majority of candidates gained some credit for this question. The most common mistake was to have the arrows in B and D pointing toward the centre of the magnet rather than to the S-pole.

(b) This question was understood and answered correctly by most candidates.

(c) While a majority of candidates answered corrected, the most common incorrect answer given was iron.

Question 8

(a) (i) The operation of a relay seems poorly understood by many candidates with only a small minority gaining full credit for this question.

(ii) Few candidates did this question well with many candidates failing to link the need for a low resistance to reduce heating in the cable.

(b) (i) The majority of candidates understood the requirements of this question. A common error was to state that the current was twice that in the fuse.

(ii) Many candidates gave a valid reason for connecting the lights in parallel.

Question 9

(a) (i) Most candidates clearly identified the thermistor. However, a significant number of candidates thought that the variable resistor was a thermistor.

(ii) The vast majority of candidates drew a correct symbol for a voltmeter, but many of these were connected in series with the thermistor.

(b) (i) Many candidates struggled with this calculation, failing to use the table to determine the current in the thermistor, and attempting to divide the potential difference across the thermistor by 20 (°C). Many others used incorrect rearrangements of $V = IR$.

(ii) The vast majority of candidates gave very clear and accurate explanations.

Question 10

(a) The majority of candidates gained full or partial credit for this question.

(b) This question was generally done well and candidates were clearly well rehearsed in drawing ray diagrams for thin lenses. Only the weakest candidates failed to gain any credit.

Question 11

(a) Most candidates completed this correctly. The most common error was to select alpha radiation as having the greatest speed.

(b) (i) The majority of candidates gained some credit here.

(ii) The vast majority of candidates gained full credit for this question.

(iii) Many candidates correctly identified the emitted particle as an alpha particle. A common mistake by weaker candidates was to state that it was an electron.

Question 12

(a) (i) The majority of candidates were able to identify the turbine.

(ii) Most candidates were able to give two distinct disadvantages although some weaker candidates often repeated the same disadvantage or gave a response in such general terms that it was not creditworthy, e.g. pollution.

(b) Only weaker candidates failed to gain any credit on this question. The most common error was incorrect rearrangements of the transformer equation.

(c) A small minority of candidates answered this question correctly. The advantages of transmitting electricity at high voltages proved challenging for the vast majority of candidates.

PHYSICS

Paper 0625/31
Extended Theory

Key Messages

- In numerical questions, a mark is usually available for the statement of a correct formula. Candidates usually learn and recall basic formulae such as $F = ma$ or $d = m / V$. Candidates should be advised to start a numerical answer by writing down the basic formula, then to transpose it if necessary making sure the numbers substituted have the correct units. This will avoid errors in the use of a wrongly transposed versions of such a formula or instead with numbers substituted in the wrong version. All candidates are strongly advised to write down the learned formula for reference.
- Also in numerical questions, marks can be lost for stating answers with wrong or missing units, the latter possibly through haste rather than from lack of knowledge. Candidates should be reminded to check their answers for units in particular.

General Comments

There were a number of very strong performances from candidates with excellent demonstrations of subject knowledge and understanding and clear presentation of this.

Candidates should remember to read the questions with greater care to ensure they understand the focus of the question. In explanations and descriptions, they should make the required points in a logical order and avoid any tendency to make the same point in different ways.

Some parts of the questions on the paper are based on the Core syllabus. There are candidates for whom these questions are the only ones that they can, in general, answer with apparent confidence. However, it is commendable that some of these candidates manage to enhance their overall performance with acceptable responses in other parts of the paper.

Comments on Specific Questions

Question 1

(a) A number of candidates failed to mark a point on the graph. The vast majority of those who did mark a point, placed it in a correct position.

(b) (i) Many correct solutions were seen. Some candidates failed to read the y-axis scale correctly. A wrong unit, usually m / s, was common.

(ii) The area under the relevant part of the graph was required. Some candidates suggested this, or wrote down a formula for the area of a triangle or trapezium, and could gain partial credit. Many went on to calculate the correct distance.

(c) Correct answers were extremely rare. The information that the resultant force on the sled was constant had not been noted or its significance not recognised. Many irrelevant answers, some suggesting a change in the resultant force, were seen.

Question 2

(a) Good knowledge of scalar and vector quantities was apparent.

(b) This question was not, in general, answered very well. Many candidates failed to write down $F = ma$, a transposed version of this, or a correct division of numbers. A division of the correct numbers with the correct units was needed, but frequently there was no conversion or a wrong conversion of kN to N. Mistakes over the unit were common.

(c) There was a wide variation in the standard of responses to this question. There were many cases of candidates seemingly drawing the resultant of the two velocities given but not taking note of the fact that one of the given vectors was the resultant velocity. The meaning of the scale of a vector diagram was clearly not understood by many.

Question 3

(a) Most candidates could recall mgh and use the formula successfully.

(b) (i) There was less success here than in the first part of the question with some candidates using *F/d* to calculate work.

(ii) This question proved challenging for all candidates. Candidates needed to calculate kinetic energy and many candidates recorded $1/2\,mv^2$, and attempted to evaluate this using various values of *v*. Only a small minority of candidates correctly calculated the difference between the two previous answers.

(c) Very many good answers were seen for this question.

Question 4

(a) In this example of the requirement to transpose a formula, a good majority were successful.

(b) (i) The required transposition of $d = m/V$ was largely successful and most arrived at a correct value of the mass of water.

(ii) While stronger candidates gained full credit for this question, a number of candidates failed to add 15 to the temperature rise that they calculated. Those who wrote down $E = Pt$ could be awarded partial credit. Many candidates chose to use numbers at the outset and mistakenly used 8500×1 instead of 8500×60 or used the power as the energy.

Question 5

(a) There needed to be separate references to smoke particles and to air molecules. In many answers it was difficult to determine which of these was being referred to. Credit was given for describing the motion of the particles and the molecules as random, and the mention of collisions between the two.

(b) (i) It was common to see the motion of the piston described as moving back, which could not be interpreted as outwards or to the right, as required. Very few realised that, overall, the pressure of the gas remained constant.

(ii) This question was generally answered successfully.

Question 6

(a) Although many correct comparisons of compressions and rarefactions were seen, it was not uncommon to see the spacing of waves referred to rather than the spacing of particles or molecules.

(b) (i) As in some previous examples, mistakes were frequently seen in the change from the formula $v = f\lambda$ to the one needed, $\lambda = v/f$. The unit of the wavelength was sometimes written as λ.

(ii) There was some success in calculating the time for compression A to advance by a distance of one wavelength, but it was rare to see this time multiplied by 2.5, the number of wavelengths it needed to advance to reach the barrier.

(c) In general, candidates had understood the basic idea of what happens to the wave. Better answers used compasses to draw the arc.

(d) This was answered correctly by the majority of candidates.

Question 7

(a) (i) Many candidates answered this question well. The most common error was that of ticking two descriptions of the image that contradicted each other.

(ii) Most candidates could indicate a correct position for an eye to be placed.

(iii) A magnifying glass or lens was the most frequently rewarded answer. It was common to see a mirror mentioned.

(b) Many totally accurate ray diagrams were drawn. Less accurate diagrams were produced by candidates who failed to include a vertical straight line or simply a dot at the centre of the lens. Some of these measured distances from the surface of the lens.

Question 8

This question was answered very well by most candidates. Those who did not gain full credit were likely not to have known the formula $Q = It$ in answering **(a)**, or to have made a unit error in one or other of the parts.

Question 9

(a) The device was nearly always correctly named as a transformer.

(b) Answers to this question revealed many misconceptions of how a transformer works. There were, for instance, frequent mentions of current transfer through the core. A number of candidates had the correct general idea but either missed the alternating nature of the magnetic field in the core, or failed to describe this field cutting or linking with the secondary coil.

(c) (i) There were many correct calculations. However, there were a significant number of candidates who used the given data incorrectly without first stating the formula being used.

(ii) About half of the candidates ticked the correct box.

Question 10

(a) This question required the recall of learned material. About two-thirds could identify the OR gate in **(i)** and correctly label an input and the output in **(ii)**. Fewer, about a half, could draw a NAND gate in **(iii)**.

(b) The needle in **(i)** should have shown no deflection. This was often shown incorrectly.

Question 11

(a) Many candidates correctly suggested that the number of neutrons would be different in the two isotopes. Many suggested nucleons instead of neutrons and could not be credited. Only a few candidates suggested protons.

(b) (i) Most candidates had clearly understood the method of showing proton and nucleon numbers of nuclei in a grid. Many candidates gained full credit for this question.

(b) (ii) This question proved challenging with fewer than half of the candidates calculating the count rate successfully.

PHYSICS

Paper 0625/32
Extended Theory

Key Messages

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

- Many candidates showed gaps in their knowledge of certain areas of the syllabus. Relatively few had good knowledge of the thermocouple in **Question 5(b)** and many weaker candidates had little knowledge of Brownian motion in **Question 6**.
- Credit can only be gained by the specific answers required, not for comments on related matters or a general discourse about the situation. This occurred frequently in **Questions 3 (b)(ii)** and **5(a)**.
- Overall the English language ability of the vast majority was adequate for the demands of this paper. Only a small minority of the candidates had difficulties with the English language and struggled to express themselves adequately. However, in **Question 6**, many candidates were not secure in their use of the appropriate terminology.

General Comments

A high proportion of candidates had clearly been well taught and were prepared for this paper. Equations were generally well known but the use of equations 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.

Generally candidates followed the instructions in the questions. There were a few examples in questions involving tick boxes where candidates gave more answers that instructed, some of which would obviously be mutually contradictory.

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.

The use of units by most candidates was good, but there was a significant number of instances of wrong units for moment in **Question 4(b)**.

Comments on specific questions

Question 1

(a) (i) Only stronger candidates stated that the comet travelled in a straight line. The majority of candidates repeated information from the question merely stating that the speed or velocity were constant sometimes adding that acceleration was constant.

(ii) The majority of candidates gained full credit. A few attempted to work out the area under the whole of the graph and consequently lost credit.

(b) This was well answered with many stating slowing down or deceleration with stronger candidates also recognising that the deceleration was not constant.

(c) Only the most able candidates were able to work out the gradient of the speed-time graph correctly. Many candidates simply took the speed and time co-ordinates of a single point at 11 s. Many of those candidates attempting to find a gradient simply used something like (36000-18000)/11, which would be the average deceleration from t = 0 to t = 11s.

(d) This was generally well answered.

Question 2

(a) The majority of candidates gained full credit.

(b) (i) The majority of candidates answered correctly.

(ii) There were many good attempts at a description to determine the volume of wood. However, weaker candidates forgot the use of the brass to ensure that the wood was completely submerged or described it in such vague terms that little credit could be given.

Question 3

(a) (i) The majority of candidates answered correctly. A common error was to give a vague statement such as power is the work done in a certain time.

(ii) Most candidates gained full credit.

(b) (i) This was well answered by stronger candidates. Weaker candidates forgot either to find the total weight of passengers, or to convert the mass of passengers into a weight. The weakest candidates forgot both.

(ii) This question was not well answered. Most candidates wrote a standard answer of heat loss perhaps not realising that this was ruled out by the statement ‘other than friction’ in the question. Some also wrote about heating in the motor due to the current in wires, not realising that this was irrelevant to the comparison of the power supplied by the motor with the power needed to transport the passengers.

Question 4

(a) Many candidates gained full credit, and some drew very good vector diagrams. Some candidates made things difficult for themselves by rotating the vectors through 90° or even 180°. Many weaker candidates failed to state or even use a suitable scale when drawing the vectors, which often led to incorrect work and a loss of credit.

(b) (i) The idea of moment = F x d was well known. However, quite often the wrong perpendicular distance was used which gave the wrong moment. The units of a moment were not always well known, sometimes kN / m or even J were used.

(ii) Only the most able candidates gained full credit. The weakest candidates tried to answer this by simply comparing the weight of the car with the moment or the force produced by the elephant.

Question 5

(a) Very few candidates answered this question well. The majority of candidates merely gave the definitions of range, linearity and sensitivity, with no link to either thermometer X or thermometer Y. Frequently, especially in parts **(ii)** and **(iii)**, reference was made to accuracy or speed of response, neither of which was part of the question. Candidates need to read what the question actually required rather than recording some well-learned facts, which may be generally related to the topic, but do not answer the question asked.

(b) (i) Some very good diagrams were seen, along with some very poor ones. Weaker candidates often gave an answer in terms of a liquid-in-glass thermometer. Of those candidates gaining credit, good diagrams were sometimes let down by not indicating different metals or, if a candidate did show different metals, one or both of the junctions were non-existent simply consisting of two wires hanging down into a liquid.

(ii) Very few candidates gained full credit, indicating a general lack of comprehension of the operation of a thermocouple. There were many vague answers about sensitivity.

Question 6

(a) There were some clear labelled diagrams, but the majority of candidates either failed to label the particles or to include a microscope. A significant minority of candidates thought the question was about diffusion, the differences between solids, liquids and gases or how a gas exerts a pressure.

(b), **(c)** Some candidates struggled to record their answer coherently for this question. In this topic the use of the appropriate terminology is essential to convey the ideas of Physics correctly. Candidates should learn the distinction between particles and molecules in explaining Brownian motion.

Question 7

(a) Most candidates gained credit here. A common error was to state that a compression is when waves are closer together.

(b) (i) Many candidates started with the correct method, but thought there were 6 wavelengths between P and Q so divided 8.5 by 6.

(ii) Many candidates having correctly given the wavelength in **(b)(i)** were unable to go on and use this information in the correct equation. The main problem was the inability of many candidates to convert 25 ms to 0.025 s.

(c) Only the most able candidates drew completely correct diagrams. Less able candidates often drew reflected waves at the wrong angle, the most common being parallel or at 90 degrees to the barrier. The weakest candidates drew refracted waves beyond the barrier.

(d) The majority of candidates gained credit for correct linkage between wave length and wave speed. However, a significant number of candidates did not know sound travels faster in water.

Question 8

(a) The majority of candidates gained full credit. The most common errors were labelling object and image the wrong way round, incorrectly placing the principal focus or putting arrows on rays in the wrong direction. A significant proportion of candidates seemed to think that because the observer looked towards the image, the lights rays would be travelling away from the observer's eye. Some put arrows in one direction on the full rays and arrows in the other direction on the dashed rays.

(b) Many candidates gained full credit. There was some very careful, accurate drawing of the angle of refraction. Whilst the correct equation was often known, there were many candidates who incorrectly measured the angle of incidence. Another common error in the calculation was to determine the critical angle.

Question 9

(a) Many candidates gained full credit. A common error was to write digital values as the input and output rather than labelling them input and output.

(b) Most candidates were able to draw the correct symbol for a fuse.

(c) (i) Most candidates correctly answered this part, but a significant number confused the thermistor with an LDR and answered in terms of light levels.

(ii) Many candidates correctly related resistance change of the thermistor with temperature change, but did not then proceed to explain the correct working of a potential divider.

(d) This questions was generally answered well. The most common error was an incorrect statement of the equation for calculating the resistance of resistors in parallel.

Question 10

(a) Many candidates gained full credit, but a significant number drew curved lines to represent the magnetic field, and only the most able spaced the lines evenly.

(b) (i) Most candidates gained credit, showing that the concept of electromagnetic induction was well known. Weaker candidates failed to realise the question was linked to electromagnetic induction, making a statement about the ammeter registering something.

Many stronger candidates failed to appreciate that the question involved a digital meter and referred to the movement of a needle.

(ii) A significant number of candidates failed to appreciate that the speed and direction of the movement of the wire has an effect on the size and direction of current. Answers such as 'same as' or showing no effect on direction of current were common.

Question 11

(a) Most candidates gained full credit here. Weaker candidates struggled with the concept of half-life e.g. multiplying by 7 days then by 21 days.

(b), **(c)** Only the weakest candidates failed to answer these part questions completely correctly.

PHYSICS

Paper 0625/33
Extended Theory

Key Messages

- Candidates should ensure they record their answers clearly and succinctly.
- It is important that units are given where the question calls for this. Candidates should also be reminded to check that they have given the correct unit.

General Comments

The levels of attainment varied very substantially on this paper and this reflected the varying levels of understanding of the candidates; there is, of course, no substitute for being familiar with the topics listed in the syllabus. It is usually better to give a reasonably short answer to a question that directly answers the point being assessed rather than attempting to set the answer in context. This can lead to points being made that contradict the intended answer or which lead to ambiguity or vagueness.

Comments on Specific Questions

Question 1

(a) This was commonly well answered, but there were some candidates who simply stated what happened to the speed and offered no explanation in terms of the forces. *The forces acting are equal* was not a sufficiently precise explanation.

(b) The point P was almost universally correctly positioned, although it was not always labelled.

(c) (i) Many candidates obtained a correct answer by a suitable method and obtained full credit. There were those who misread the scale of the graph; the point (0.25, 2.5) was occasionally taken as (0.25, 2.25).

(ii) This part of the question was less well answered. Many candidates tried to apply the formula $x = vt$ rather than making an estimate of the area under the graph.

Question 2

(a) (i) This value was usually determined correctly, but the answer was not always given to two significant figures. The figures in the question are all given to at least two significant figures and this precision was expected in the candidate's answer.

(ii) This calculation proved challenging for some candidates as it was necessary to take into consideration the fact that the only mass that was supplied in the question was the mass of a $1.0\,m^2$ sheet of the paper. Many candidates produced answers that were 500 times too small. Candidates who used an inaccurate definition of density were unlikely to obtain any credit at all.

(b) Only a micrometer screw gauge or an electronic calliper can produce a measurement that is 100 times more precise than a rule. A Vernier calliper would only be 10 or perhaps 20 times more precise. In this second case, where only five sheets of paper are available, only the former two instruments will suffice.

Question 3

(a) (i) This was very frequently correct.

(ii) This name was only known by the strongest candidates. Many candidates supplied an answer which to some extent described what was happening rather than using the generally accepted name for this point.

(b) Although many candidates multiplied a force by a distance, the numbers 6.0 and 3.0 were only used by a minority of candidates. Of these, many left the answer as 18 (J) rather than as 0.18 J or 18 N cm.

(c) (i) Many candidates attempted this calculation in the correct way and obtained the correct final answer. Others made some progress but left 8.0 N as the final answer.

(ii) This calculation was also frequently correct. This was sometimes absolutely correct but others obtained full credit as a result of an erroneous answer to **(c)(i)** being used correctly in this part.

Question 4

(a) Energy changes were asked for in this part and in each of the three cases an initial energy and a final energy was expected. A significant number of candidates suggested only one type of energy in some or all of the three parts.

(b) This calculation resulted in a wide variety of answers. Many candidates knew the correct formula, made the correct substitution and gave the correctly calculated answer with the unit. It is worth noting that there were some candidates who wrote down the formula $KE = \frac{1}{2}mv^2$, but omitted the square from either the substitution or from the calculation. It is, of course, possible to obtain the correct answer using the equations of kinematics but this approach can be more complicated and only occasionally did such candidates obtain full credit when taking this approach.

(c) Many candidates had some idea of what was expected, but not all of these gave sufficiently detailed or exact suggestions.

Question 5

(a) This question was challenging for many candidates. Although there were some correct answers, many candidates gave answers such as *sensitivity*, *range*, *ice-point*, *steam-point*, *mercury*, *ethanol*, *narrow bore* or *thin glass*.

(b) (i) There were many good answers and full credit was quite commonly obtained. However, the question asked for two procedures and some candidates merely defined what was meant by the fixed points.

(ii)1 This question was generally well answered.

(ii)2 Many candidates correctly stated that solids expand less than liquids, but other realised that the expansion of the glass was taken into account when the thermometer was first calibrated.

Question 6

(a) Many candidates gave the definition of *refraction* even though the term *rarefaction* was used in the next part of the question in a context which made this interpretation unlikely.

(b) (i) Although the answers given here were very often correct, common incorrect answers included 0.76 m and 0.152 m.

(ii) There were many correct answers here. Although one or two more direct routes to the answer were possible, some candidates chose rather more circuitous approaches and this created a greater scope for error.

(c) Some candidates knew what the effect of the sound's passing into the wood was and produced correct answers.

(d) Some candidates redrew Fig. 6.1 in the space below the question before sketching their answer. This was unnecessary and probably quite time consuming. There were many good answers here, with only a minority of candidates drawing the rarefactions that would have resulted from a reduction in the speed of the wave.

Question 7

(a) The candidates who were familiar with the most appropriate and direct formula very commonly obtained full credit although occasionally an incorrect substitution or an inaccurate calculation led to an incorrect final answer. The candidates who tried to use the formula $\sin i / \sin r = n$ rarely obtained the correct answer.

(b) This part was well answered by many candidates and full or nearly full credit was quite commonly awarded. A few candidates stated that total internal reflection occurred when the angle of incidence was less than the critical angle but not when it was larger. Some other candidates took the critical angle as 41.8° even though in this part, the use of the general term *critical angle* was expected.

Question 8

(a) This was very often correct although not always spelt correctly. Given the wording of the question, the symbol *C* on its own was not accepted. Some candidates suggested *ampere*, *volt* or *watt* or even *electron*.

(b) (i) This was well answered with most candidates drawing an equal number of positive charges and negative charges.

(ii) This part was less well answered with only a minority of candidates being awarded full credit. It was commonly stated that the positive charge on the larger sphere repelled positive charges down the wire or even attracted negative charges across the gap between the two spheres. Others stated that the effect of earthing the smaller sphere was to leave it completely uncharged or neutral.

(c) This was well-answered by the majority of candidates.

Question 9

(a) Some candidates placed a tick in each column and not, as instructed, in each row. The use of a transistor as a switch was not always understood and the tick in the bottom row was frequently positioned in the *rectifier* column.

(b) A number of candidates obtained full or nearly full credit here but other candidates gave answers where the explanations were not sufficiently detailed. A few candidates interpreted the symbol of component B to be that of a thermistor whilst others stated that the resistance of a light-dependent resistor increases as the intensity of the incident light increases. There were also some rather confused answers which suggested that by decreasing the current in B, there was more current available for the lamp.

Question 10

(a) Although there were many answers to this part which obtained full credit, there were also some rather confused answers. A few candidates stated that increasing the transmission voltage decreases the resistance of the transmission cable. Rather more candidates suggested that increasing the voltage ensured that there was still enough voltage at the far end for the consumer. Another common suggestion was that the higher the voltage, the less time the energy would take to travel the long distance.

(b) Parts **(i)** and **(ii)** of this question were commonly correctly answered.

(iii) This calculation was sometimes performed correctly and sometimes not. This was a question where the correct formula was not invariably rearranged correctly.

(c) There were many sensible suggested reasons here.

Question 11

(a) (i) An answer which only referred to the different numbers of nucleons in the two isotopes was not accepted. Candidates were expected to refer to the different number of neutrons. This was very commonly done and many candidates obtained full credit.

(ii) This was often correctly answered.

(b) A significant number of candidates were able to suggest one or two appropriate reasons for the stronger ionising effect of α-particles.

(c) (i) While there were many clear, correct answers, there were other answers that hinted at the correct answer, but which also suggested a slightly unclear understanding of the composition of the atom.

(ii) Only the strongest candidates produced a correct answer here.

PHYSICS

Paper 0625/04
Coursework

General Comments

There were too few candidates for us to be able to produce a meaningful report.

PHYSICS

Paper 0625/51
Practical Test

Key Messages

- Candidates need to have had a thorough grounding in practical work during the course, including reflection and discussion on the precautions taken to improve reliability and control of variables.
- Candidates should be aware that, as this paper tests an understanding of experimental work, explanations and justifications will need to be based on practical rather than theoretical considerations.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit where applicable. Candidates should know that these techniques are tested at some point in the paper.
- Candidates should be ready to apply their practical knowledge to different situations.
- Questions should be read carefully to ensure that they are answered appropriately.

General Comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques, including the following:

- plotting graphs
- tabulating readings
- manipulating data to obtain results
- drawing conclusions
- dealing with possible sources of error
- controlling variables
- handling practical apparatus and making accurate measurements
- choosing the most suitable apparatus.

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 required, for example in **Question 1 Parts (a)**, **(b)(iii)** and **(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.

Comments on Specific Questions

Question 1

(a) Candidates needed to know how to avoid a parallax error. There are several acceptable answers, such as looking perpendicularly at the metre rule scale or using a set-square as a horizontal guide across the centre of the bob and the scale.

(b) (i) Most candidates were able to measure the time *t* to within the tolerance allowed.

(ii) Partial credit was awarded to candidates giving a reasonably accurate reading. To gain full credit candidates needed to show that they had exercised greater care and obtained a result within a narrower tolerance.

(iii) The strongest candidates explained that the reaction time inaccuracy is a smaller part of the total time measured. Weaker candidates referred to the average of 20 separate readings and this was not credited.

(c) Most candidates recorded the values within the tolerance allowed and included the units with their readings.

(d) The answers here were judged on the candidates' readings. Most noticed that T_C was not equal to T_S, but few went on to offer a suitable justification in terms of the results being too different to be within the limits of experimental accuracy.

(e) This could be answered in a number of ways. The most straightforward, although not often used, was to point out that the pivot of the second pendulum was at the 1 cm mark.

Question 2

(a) Most candidates recorded an appropriate value for room temperature.

(b) Most candidates recorded an appropriate value for the temperature of the hot water. This was often followed by a suitable precaution.

(c) Most candidates recorded a realistic value of the temperature, between room temperature and the temperature of the hot water.

(d) Some candidates recorded the average temperature as below that of the temperature of the mixture, showing that they had misread the thermometer or not exercised sufficient care in some other way. The majority of candidates gave the correct unit for temperature (ºC) throughout.

(e) Many candidates found this part challenging. Stronger candidates referred correctly to heat loss to the surroundings, delays in taking readings or uncertainty about the exact volume of cold water. Some answers hinted at the correct response but were too vague to be credited.

(f) Most candidates could identify the correct reading. Many could explain the error made in taking the reading at the bottom of the meniscus. Fewer used the alternative correct response, explaining the scale divisions.

Question 3

(a) Most candidates recorded a realistic current. This needed to be expressed to two decimal places to be credited. Most candidates recorded a sensible set of potential difference values to at least one decimal place.

(b) Most candidates labelled the graph axes correctly and drew them the right way round. Those who chose scales that produced plots that occupied more than half of the graph grid in both directions were credited. Plotting was generally accurate. Many candidates drew a well-judged straight line although some were inaccurate due to drawing a 'dot-to-dot' line. Others drew a straight line that did not match the plots. Some answers could not be credited because the line was too thick or the plots too large.

(c) Candidates were expected to read the value of the intercept to within half a small square of the graph paper. A correct ratio that was within the tolerance was credited. This rewarded candidates who had exercised care throughout. Most candidates gave their answer to two or three significant figures and included the correct unit (Ω). However, a significant number of candidates gave a value that was not the same as the ratio Y/I.

Question 4

(a)–(l) Many candidates drew their ray-trace with care and accuracy, gaining credit for correct positioning of the normal and incident ray. A significant number, however, did not place the pins sufficiently far apart even though some claimed to have done this in **(m)**. Most candidates produced reflected rays in the expected area but some appeared unfamiliar with this basic work on reflection and drew rays behind the mirror. Candidates were rewarded for a good level of care and accuracy in completing the table.

(m) Many sensible responses were seen here but some candidates made suggestions that did not answer the question or were too vague to be credited.

(n) Candidates needed to realise that the question stated that the experiment had been carried out very carefully and to make a suggestion about the apparatus or procedure that was not effectively saying 'it was done carelessly'. The difficulty in exactly lining up the pins (in spite of great care), or the problem caused by the thickness of the mirror are examples of valid answers.

PHYSICS

Paper 0625/52
Practical Test

Key Messages

- Candidates will need to have had a thorough grounding in practical work during the course, including reflection and discussion on the precautions taken to improve reliability and control of variables.
- Candidates should be aware that as this paper tests an understanding of experimental work, explanations and justifications will need to be based on practical rather than theoretical considerations.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. Candidates should know that these techniques will be tested at some point in the paper.
- Candidates should be ready to apply their practical knowledge to different situations. Questions should be read carefully to ensure that they are answered appropriately.

General Comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques. 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 concepts of results being equal within the limits of experimental accuracy
- dealing with possible sources of inaccuracy
- control of variables
- choosing the most effective way to use the equipment provided.

The majority of candidates entering this paper were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. 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 almost always 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.

The gathering and recording of data presented few problems for many 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 being used, or to quote a derived result to an appropriate number of significant places, still causes difficulty for many candidates. 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.

Comments on Specific Questions

Question 1

(a) The distances *a* and *b* were usually recorded, as requested, in the table. Errors were sometimes made when candidates did not record their results to the nearest millimetre, despite using a metre rule with millimetre graduations. The distances of the masses **P** and **Q** to the ends of the metre rule were sometimes recorded, despite the required distances being marked on **Fig. 1.1**.

(b) The majority of candidates repeated the procedure carried out in part **(a)** to produce a complete table of results.

(c) The improvement in the standard of graph plotting commented upon last year, was not maintained this year. Many candidates chose horizontal and vertical scales that did not make use of at least half of the given grid. There was more evidence of the use of scales that increased in inconvenient increments, such as 3 or 7. Choosing such scales makes the points much harder to plot and more prone to error.

There were still too many graphs where the points were joined dot-to-dot, and even when best fit lines were attempted, they were often biased to one side, or even forced through the origin. The concept of best-fit is clearly still not well understood by all.

(d) Most candidates were able to make an attempt to determine the gradient of the graph they had drawn. However, many candidates ignored the given instruction to indicate clearly on the graph evidence of how they had obtained the necessary information. It is expected that the coordinates chosen to calculate the gradient, or the triangle drawn on the graph, indicate that candidates are using at least half of the line that they have drawn.

(e) Candidates found this final part of the question difficult, with only the more able candidates providing accurate answers. Even though a wide range of tolerance for candidates' answers was allowed, the responses given by candidates ranged in value from fractions of a gram to several kilograms. Most candidates did not show an understanding of the size of mass that would be used in balancing experiments of this type.

Question 2

(a) The majority of candidates recorded a sensible value for the temperature of the hot water in the beaker.

(b)(c) Almost all candidates were able to follow the instructions given and produced a completed table showing how the temperature of the water changed both before and after the volume of cold water was added, with time. Occasionally, the unit C°, instead of °C, appeared at the head of the temperature column.

(d) The calculation of both temperature changes was done well, but candidates found the last part of the question challenging. Many candidates did not realise that as the water cooled, the rate of cooling would decrease as the temperature of the water approached room temperature.

(e) A majority of candidates realised that when reading a thermometer scale, it is necessary to take the reading at right angles to the scale. Candidates should be advised that merely writing 'avoid parallax' is insufficient. Candidates must state how this is done. Some candidates thought that the eye should be parallel to the thermometer scale.

(f) Candidates must be precise when answering this type of question. Merely stating different water temperatures was insufficient. Candidates needed to state that the initial temperature of the hot water was different. The most usual route to success here was for candidates to state that the room temperature might be different.

Question 3

(a) The majority of candidates recorded the ammeter and voltmeter readings. Reading were often not quoted to a sufficient number of decimal places, consistent with the resolution of the meters used. The resistance calculation was usually correct, although rounding errors sometimes occurred.

(b) The majority of candidates drew a correct circuit, although in some cases it had been drawn freehand and was very untidy. Weaker candidates either failed to label the resistors, or drew the series/parallel combination of resistors incorrectly.

(c) The calculation of the combined resistance R_2 and the ratio R_1/R_2 was usually performed correctly. Many candidates incorrectly included a unit with their value of the ratio.

(d) Most candidates were able to state whether or not their results supported the statement given. However, only the strongest candidates were able to give a convincing justification for their statements. The idea of experimental tolerances and whether two measured quantities are close enough to be considered equal is not well understood by the majority of candidates.

Question 4

(a)–(g) The majority of candidates drew the normal correctly and drew the incident ray at an angle of incidence of 30°. Occasionally the angle of incidence was drawn at an angle of 60° to the normal. Despite the instruction that the pins were to be placed a suitable distance apart, many candidates placed the pins far too close together. In experiments such as this, the pins need to be placed at least 5 cm apart, and further, if possible.

The reflected rays were almost invariably drawn in the correct positions. Ray diagrams were, on the whole, neatly drawn with sharp pencils.

(h) Most measured angles of reflection were within the tolerance limits set.

(i) Candidates are now familiar with listing precautions for obtaining reliable results when performing optics experiments. On this occasion, candidates were asked to list two precautions that they would take with the pins. Fewer than half of the candidature was able to give two precautions, although most were able to give one. Many other irrelevant precautions were given which did not relate to the question as it had been set.

(j)–(l) The practical work involved here was exactly the same as in parts **(a)–(g)**, and the same comments as above apply.

(m) Correct answers to this question were rare. Only the most able candidates realised that the mirror and the pins had thickness and all the incident and reflected rays would not necessarily meet at point **A**.

PHYSICS

Paper 0625/53
Practical Test

Key Messages

- Candidates will need to have had a thorough grounding in practical work during the course, including reflection and discussion on the precautions taken to improve reliability and control of variables.
- Candidates should be aware that as this paper tests an understanding of experimental work, explanations and justifications will need to be based on practical rather than theoretical considerations.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. Candidates should know that these techniques will be tested at some point in the paper.
- Candidates should be ready to apply their practical knowledge to different situations. Questions should be read carefully to ensure that they are answered appropriately.

General Comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques, including the following:

- plotting graphs
- tabulating readings
- manipulating data to obtain results
- drawing conclusions
- dealing with possible sources of error
- controlling variables
- handling practical apparatus and making accurate measurements
- choosing the most suitable apparatus.

Questions on experimental techniques were answered much more effectively by candidates who clearly had regular experience of similar practical work.

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 **Question 1(d)**, which required references to results rather than theory, and in the clear practical details given by some candidates in **Questions 3(a) and 4(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 **Question 1(c)** and in clear explanations given in **Question 3(e)**.

Candidates may be asked to develop techniques previously described in a question. Many candidates showed good basic practical knowledge when answering **Question 4(e)**.

Comments on Specific Questions

Question 1

Overall, this question was well done by many candidates but a number had difficulty with interpretation of results.

(a) Candidates generally appreciated that voltmeters are to be connected in parallel. However, the simplest diagram with a voltmeter connected in parallel between the vertical arms of the circuit was seen in only a few responses. The consequences of incorrectly drawn voltmeters were not always seen in **(b)** and it was assumed that the meters were connected correctly before results were recorded.

(b) Many candidates carried out appropriate measurements, recording potential differences to at least one decimal place and currents to at least two decimal places. In most cases, currents increased as more wires were added in parallel.

(c) Most candidates gave correctly calculated responses to two or, more often, three significant figures. Units were sometimes neglected and some credit was lost because of this.

(d) (i) Many candidates were able to recognise that the student's suggestion was correct and gained credit, provided that values from the results were given in support of their answer. It was clear, however, that a number of candidates did not appreciate that the values were 'close enough' and expected them to be identical for the suggestion to be correct.

Some candidates failed to gain the second mark by not justifying their statement with an explanation of 'within the limits of experimental accuracy' or by referring to theory rather than the results.

(ii) Correct responses stated that R_3 was 1/3 R_1, following the pattern from the simple relationship between R_2 and R_1 suggested in **(d)(i)**. The response to this question was used as an indication of how accurately the experiment had been carried out and alternative relationships, even if matching results, were not given credit. A suggested relationship of 'approximately 1/3' was also unacceptable.

There were a number of incorrect answers which referred to the theory of parallel circuits in general without mentioning the resistances in question.

Question 2

This question was done well by many candidates, although a number had difficulties with some aspects.

(a) Nearly all candidates were able to construct a normal in the correct place.

(b) Many candidates labelled pin positions which were a suitable distance apart but a significant number attempted to place pins exactly 5.0 cm from each other. This figure indicates the recommended minimum pin separation and pins should be as far apart as is practically feasible. Any just under 5.0 cm apart were not given credit.

(c) The majority drew a thin, continuous, straight line through the two pin positions. A small number of candidates had clearly not read the instructions carefully and produced diagrams which were far from those expected.

(d) Most candidates had correct measurements for *a* and *b* from their diagram, shown with appropriate units.

Many candidates earned credit for a correctly calculated value of refractive index, within the expected range, chosen to indicate accurate drawing and measurement.

(e) Many candidates were able to repeat the procedure carefully, with the block in a new position on the first diagram, as indicated in the instructions. Some chose to use a second ray-trace sheet and, although this was not required, it was perfectly acceptable in this case if it helped the candidate. Use of the reverse of the first ray-trace was more problematic as existing pin holes could confuse further drawing. Candidates should be reminded to use a sharp pencil and take care with their diagrams as the quality and accuracy of lines is tested in this type of question.

(f) A majority of candidates obtained second values for refractive index which were within the acceptable 10% of that calculated in **(d)**. This of course depended on each drawing and the associated measurements being accurate. Some lost credit by attaching a unit to either value of *n*.

(g) Many candidates were able to identify that the value would be less reliable but fewer of these knew it was due to smaller measurements. Only a very small number went on to associate this with a greater percentage uncertainty.

A number of candidates incorrectly thought there would be less refraction.

Question 3

This question produced a significant variation in responses.

(a) Many candidates opted to explain how to avoid parallax error, generally illustrated with a diagram. It is important that if candidates draw diagrams in support of written answers, they should be carefully constructed so as to avoid contradiction. Some candidates showed rulers clearly too far from the spring or drew lines-of-sight incorrectly.

A large number of responses suggested that the spring should be still before measuring. This was taken to be standard experimental technique and did not gain credit unless a further correct precaution was also mentioned.

Most tables contained increasing values of *l* expressed to at least 1 decimal place.

(b) Some good graphical skills were seen, with clearly labelled axes and accurate plots indicated 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 see correctly plotted values. The large dots used by an increasing number of candidates are not acceptable as the intended value cannot be determined clearly. A sharp pencil should be used for the plots and for the line so that accurate drawing may be achieved and errors easily corrected.

Scales were usually sensible. Only a few candidates had used impractical scales, with intervals of 0.3 or 0.6. A number of candidates made errors by plotting points on a line when they should have clearly been in the middle of the gap between two lines.

Many candidates produced a fine, straight, well-judged line of best-fit and only a very few failed to join points together. There was a tendency by some to force the line incorrectly through the origin or to ignore ‘inconvenient’ points, treating them as outliers when they clearly were not. Candidates should be aware that only points lying well outside the trend of the other plots should be treated in this way and marked as such.

(c) Most candidates were able to interpret the intercept correctly.

(d) The majority of candidates recorded a measurement for the length of the extended spring and most went on to give a value for *W* which was in the expected range. However, construction lines shown on the graph were not always accurate or clear, and were sometimes missing.

(e) Many candidates recognised that the given answer was expressed to an excessive number of significant figures but often gave explanations which lacked clarity or detail. The majority of correct responses referred to the data in the table being given to only two or three significant figures or pointed out that four significant figures could not be read sensibly from the graph.

Question 4

A majority of candidates performed well on this question.

(a) Most candidates recorded increasing values of temperature, with only a very few placing results in the wrong columns.

(b) Many candidates correctly recorded temperature values increasing more rapidly for the smaller volume of water. However, this was not always the case and sometimes it could be seen from the records of θ_H that significantly cooler water had been used in the beaker for the second part of the experiment. Where a hot water temperature is specified in the Confidential Instructions, Centres should be aware that this must be maintained throughout the experiment so as not to disadvantage candidates.

Quite a few candidates neglected units in the time column and therefore lost credit. Sometimes units were entirely missed out. However, where answers were complete, they were generally accurate.

(c) A conclusion matching the temperature changes was usually seen but a small number of candidates did not mention the temperature rise in their statement or contradicted their initial conclusion.

Where there had been an unexpected smaller temperature rise for the smaller volume of water, some candidates gave a conclusion which reflected theoretical considerations rather than being based on their results. In practical examinations, conclusions which are supported by the results obtained are generally given credit and candidates should avoid reverting to theory in such situations.

(d) Most candidates were able to identify at least one condition. Many referred to the temperature of the hot or cold water but some were not specific enough to gain credit, omitting the word ‘initial’ or ‘starting’.

‘Room temperature’ was seen as a common correct condition but candidates should be careful to distinguish this from the ‘outside’ temperature which was considered to be too vague for credit.

(e) Although many candidates found this question challenging, there were some well-constructed answers with thoughtful suggestions for improvements. The majority of these gave solutions involving the reduction of the loss of thermal energy or the increase in thermal conduction.

A common incorrect suggestion was the insulation of the glass tube, thus reducing thermal conduction. However, covering the open top of the glass tube to reduce the loss of thermal energy to the surroundings was able to be credited in many answers.

PHYSICS

Paper 0625/61
Alternative to Practical

Key Messages

- Candidates will need to have had a thorough grounding in practical work during the course, including reflection and discussion on the precautions taken to improve reliability and control of variables.
- Candidates should be aware that, as this paper tests an understanding of experimental work, explanations will need to be based on data from the question and practical rather than theoretical considerations.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. Candidates should know that these techniques will be tested at some point in the paper.
- Candidates should be ready to apply their practical knowledge to unusual situations.
- Questions should be read carefully to ensure that they are answered appropriately.

General Comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques, including the following:
- plotting graphs
- tabulating readings
- manipulating data to obtain results
- drawing conclusions
- dealing with possible sources of error
- controlling variables
- making accurate measurements
- choosing the most suitable apparatus.

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 the majority 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.

The practical nature of the examination should be borne in mind when explanations, justifications or further developments are asked for. For example see **Question 1 (c)** and **(d)** and **Question 5 (b)** and **(c)**.

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

Comments on Specific Questions

Question 1

(a) (i) Most candidates measured the length accurately.

(ii) Candidates needed to know how to avoid a parallax error. There were several acceptable answers, such as looking perpendicularly at the metre rule scale or using a set-square as a horizontal guide across the centre of the bob and the scale. This was generally well answered.

(b) (i) Many candidates were able to read the stopwatch correctly, but some recorded 28.3 s apparently thinking that the 20 had to be divided by 60.

(ii) This was generally answered correctly with just a few candidates making an error in their calculation.

(iii) The strongest candidates explained that the reaction time inaccuracy is a smaller part of the total time measured. Weaker candidates referred to the average of 20 separate readings and this was not credited.

(c) Many candidates produced a vague answer here, or one which did not address the question. A brief explanation of a good practical technique to obtain an accurate time was required.

(d) The answers here were judged on the candidates' results. Most noticed that T_C was not equal to T_S but few went on to offer a suitable justification in terms of the results being too different to be within the limits of experimental accuracy.

(e) This could be answered in a number of ways. The most straightforward, although not often used, was to point out that the pivot of the second pendulum was at the 1 cm mark.

Question 2

(a) Many candidates recorded the potential difference correctly. Most candidates recorded the current correctly.

(b) Most candidates labelled the graph axes correctly and drew them the right way round. Those who chose scales that produced plots that occupied more than half of the graph grid in both directions were credited. Plotting was generally accurate. Many candidates drew a well-judged straight line although some were inaccurate due to drawing a 'dot-to-dot' line. Others drew a straight line that did not match the plots. Some answers could not be credited because the line was too thick or the plots too large.

(c) Candidates were expected to read the value of the intercept to within half a small square of the graph paper. A correct ratio that was transferred to give the value of *R* was credited. Most candidates gave their answer for *R* to two or three significant figures and included the correct unit, (Ω).

Question 3

(a) Many candidates drew their ray-trace with care and accuracy, gaining credit for correct positioning of the normal and incident ray. The correct length of the incident ray was also credited.

(b) A significant number of candidates did not indicate the pins sufficiently far apart even though some referred to this as a precaution in **(d)**.

(c) Most candidates drew the line joining P_3 and P_4 with care and measured the angle of reflection correctly.

(d) Many sensible responses were seen here but some candidates made suggestions that did not answer the question or were too vague to be credited. Answers such as ‘do the experiment in a darkened room’ are appropriate to lens experiments, but not to this type of practical using optics pins.

(e) Candidates needed to realise that the question stated that the experiment had been carried out very carefully and to make a suggestion about the apparatus or procedure that was not effectively saying ‘it was done carelessly’. The difficulty in exactly lining up the pins (in spite of great care), or the problem caused by the thickness of the mirror are examples of valid answers.

Question 4

(a) Most candidates recorded the correct value (22 °C) for room temperature. Some recorded 20.2 °C.

(b) The majority of candidates made a relevant suggestion.

(c) Most candidates calculated the temperature change successfully.

(d) Many candidates found this part challenging. Stronger candidates referred correctly to heat loss to the surroundings, delays in taking readings or uncertainty about the exact volume of cold water. Some answers hinted at the correct response but were too vague to be credited.

(e) Most candidates could identify the correct reading. Many could explain the error made in taking the reading at the bottom of the meniscus. Fewer used the alternative correct response, explaining the scale divisions.

Question 5

(a) Most candidates drew a careful diagram showing the components in the correct positions.

(b) Very few candidates suggested a suitable distance. Most gave a value that was much too small. It was not expected that candidates would know from theory that the distance between object and screen must be at least four times the focal length. Candidates were expected to make a judgement based on their experience of carrying out lens experiments.

(c) Relatively few candidates made relevant suggestions here. Answers referring to the difficulty in deciding on the best position of the lens to obtain the sharpest image, difficulty in measuring to the centre of the lens or the room being too bright gained credit.

(d) Many candidates knew that the image would be upside down and drew a clear diagram.

PHYSICS

Paper 0625/62
Alternative to Practical

Key Messages

- Candidates will need to have had a thorough grounding in practical work during the course, including reflection and discussion on the precautions taken to improve reliability and control of variables.
- Candidates should be aware that as this paper tests an understanding of experimental work, explanations will need to be based on data from the question and practical rather than theoretical considerations.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. Candidates should know that these techniques will be tested at some point in the paper.
- Candidates should be ready to apply their practical knowledge to unusual situations. Questions should be read carefully to ensure that they are answered appropriately.

General Comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques. 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 the majority of the candidature. Most candidates demonstrated that they were able to draw upon their own personal practical experience to answer the questions. 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. This was evident in **Questions 1(d), 4(e),** and **3(d)** where the conclusions and the justifications in support of them, or the suggestions made, allowed the better candidates to demonstrate their ability.

The vast majority of candidates finished the paper and there were few scripts with substantial numbers of 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.

Comments on Specific Questions

Question 1

(a) Most candidates were able to scale up their measurements by a factor of 10 and insert these values into the given table. However, despite the instruction given to candidates asking for the distance from the centres of loads **P** and **Q** to the pivot, a number of candidates measured the distance from the edge of the loads to the pivot. A common error with the distance from the centre of load **Q** to the pivot was for candidates to record the answer as 20 mm instead of 19 mm. In measuring exercises, candidates must take care and measure to the nearest millimetre.

(b) The improvement in the standard of graph plotting commented upon last year, has not been maintained this year. Most candidates chose horizontal and vertical scales which did not made use of at least half of the given grid. There was more evidence of the use of scales which increased in inconvenient increments, such as 3 or 7. Choosing such scales makes the points much harder to plot accurately. There were still too many graphs where the points were joined dot-to-dot, and even when best fit lines were attempted, they were often biased to one side, or even forced through the origin. The concept of best-fit is clearly still not well understood by all.

(c) Most candidates were able to make an attempt to determine the gradient of the graph they had drawn. Weaker candidates ignored the given instruction to indicate clearly on the graph evidence of how they had obtained the necessary information. It is expected that the coordinates chosen to calculate the gradient, or the triangle drawn on the graph, indicate that candidates are using at least half of the line that they have drawn.

(d) Candidates found this final part of the question difficult, with only the more able candidates providing accurate answers. Even though a wide range of tolerance for candidates' answers was allowed, the responses given by candidates ranged in value from fractions of a gram to several kilograms. Most candidates did not show an understanding of the size of mass that would be used in balancing experiments of this type.

Question 2

(a) This question was generally well done. Where the thermometer was misread, the most common incorrect answer was 80.2 °C.

(b) Almost all candidates were able to follow the instructions given and produced a completed table showing how the temperature of the water changed both before and after the volume of cold water was added, with time. Occasionally, the unit C°, instead of °C, appeared at the head of the temperature column.

(c) The calculation of both temperature changes was done well, but candidates found the last part of the question challenging. Many candidates did not realise that as the water cooled, the rate of cooling would decrease as the temperature of the water approached room temperature.

(d) A majority of candidates realised that when reading a thermometer scale, it is necessary to take the reading at right angles to the scale. Candidates should be advised that merely writing 'avoid parallax' is insufficient. Candidates must state how this is done. Some candidates thought that the eye should be parallel to the thermometer scale.

(e) Candidates must be precise when answering this type of question. Merely stating different water temperatures was insufficient. Candidates needed to state that the initial temperature of the hot water was different. The most usual route to success here was for candidates to state that the room temperature might be different.

Question 3

(a) The majority of candidates read the voltmeter correctly. The ammeter reading was occasionally incorrect with the most popular incorrect reading being given as 0.26 A. The resistance calculation was usually correct, but candidates often failed to state the units or gave incorrect units in **(i)** and **(ii)**.

(b) The majority of candidates drew a correct circuit, although in some cases it had been drawn freehand and was very untidy. Weaker candidates either failed to label the resistors, or drew the series/parallel combination of resistors incorrectly.

(c) The calculation of the combined resistance R_2 and the ratio R_1/R_2 was usually performed correctly. Many candidates incorrectly included a unit with their value of the ratio.

(d) Most candidates were able to state whether or not their results supported the statement given. However, only the strongest candidates were able to give a convincing justification for their statements. The idea of experimental tolerances and whether two measured quantities are close enough to be considered equal is not well understood by the majority of candidates.

Question 4

(a) The majority of candidates drew the normal correctly and drew the incident ray at an angle of incidence of 30°. Occasionally the angle of incidence was drawn at an angle of 60° to the normal, or a refracted ray was drawn instead of a reflected ray.

(b) Most candidates knew that a suitable position for pin P_2 was at least 5 cm away from pin P_1. However, some candidates drew P_2 exactly 5 cm away from P_1.

(c) The angle of reflection was usually measured correctly and most candidates produced lines that were correctly drawn and which were neat.

(d) Candidates are now familiar with listing precautions for obtaining reliable results when performing optics experiments. On this occasion, candidates were asked to list two precautions that they would take with the pins. Fewer than half the candidature was able to give two precautions, although most were able to give one. Many other irrelevant precautions were given which did not relate to the question as it had been set.

(e) Correct answers to this part were rare. Only the most able candidates realised that the mirror and the pins had thickness.

Question 5

(a) Many candidates answered this question correctly. However, there were a number of responses that were not very clearly expressed.

(b) Many candidates gained partial credit for naming an appropriate measuring device to find the diameter of the hole left in the sand by the steel ball. Only a small number of candidates realised that to get a reliable answer, the diameter should be measured at different positions around the hole and an average taken.

(c) Most candidates realised that the size of the hole made would depend on the mass / density / diameter etc. of the ball. Far fewer candidates realised that the size of the hole would also depend upon the type / nature / dampness of the sand, as well.

PHYSICS

Paper 0625/63
Alternative to Practical

Key Messages

- Candidates will need to have had a thorough grounding in practical work during the course, including reflection and discussion on the precautions taken to improve reliability and control of variables.
- Candidates should be aware that as this paper tests an understanding of experimental work, explanations will need to be based on data from the question and practical rather than theoretical considerations.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. Candidates should know that these techniques will be tested at some point in the paper.
- Candidates should be ready to apply their practical knowledge to unusual situations. Questions should be read carefully to ensure that they are answered appropriately.

General Comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques, including the following:

- plotting graphs
- tabulating readings
- manipulating data to obtain results
- drawing conclusions
- dealing with possible sources of error
- controlling variables
- handling practical apparatus and making accurate measurements
- choosing the most suitable apparatus.

Questions on experimental techniques were answered much more effectively by candidates who clearly had experience of similar practical work.

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 4(e)**, referring to results rather than theory, and in the clear practical details given by some candidates in **Questions 1(d)** and **2(a)**.

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. This was demonstrated in many good responses to **Question 4(d)** and in clear explanations given in **Question 2(e)**.

Candidates may be asked to develop techniques previously described in a question or may well be referred to situations with which they are not familiar. A number of candidates showed good basic practical knowledge when answering **Question 1(e)** and **Question 3**.

Comments on Specific Questions

Question 1

Overall, this question was well done by a number of the better candidates. However, sections involving details of practical methods proved challenging for some.

(a) Temperature measurements were carried out accurately by the vast majority of candidates, although a few read the scale in the wrong direction, giving 92 °C rather than 88 °C, or took the intermediate graduations to be 0.1 °C and gave 20.2 °C and 80.8 °C.

(b) Quite a few candidates neglected units in the time column and therefore lost credit. Sometimes this question was missed out.

However, where answers were complete, they were generally accurate.

(c) A conclusion matching the given temperature changes was usually seen but a small number of candidates did not mention the temperature rise in their statement or contradicted their initial conclusion.

(d) Most candidates were able to identify at least one condition. Many referred to the temperature of the hot or cold water but some were not specific enough to gain credit, omitting the word 'initial' or 'starting'.

'Room temperature' was seen as a common correct condition but candidates should be careful to distinguish this from the 'outside' temperature which was considered to be too vague for credit.

(e) Although many candidates found this question challenging, there were some well-constructed answers with thoughtful suggestions for improvements. The majority of these gave solutions involving the reduction of the loss of thermal energy or the increase in thermal conduction.

A common incorrect suggestion was the insulation of the glass tube, thus reducing thermal conduction. However, covering the open top of the glass tube to reduce the loss of thermal energy to the surroundings was able to be credited in many answers.

Question 2

This was one of the questions that many candidates were able to answer most successfully.

(a) Many opted to explain how to avoid parallax error, generally illustrated with a diagram. It is important that if candidates draw diagrams in support of written answers, they should be carefully constructed so as to avoid losing credit. Some candidates showed rulers clearly too far from the spring or drew lines-of-sight incorrectly.

A large number of responses suggested that the spring should be still before measuring. This was taken to be standard experimental technique and did not gain credit unless a further correct precaution was also mentioned.

(b) Some good graphical skills were seen, with clearly labelled axes and accurate plots indicated 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 see correctly plotted values. The large dots used by an increasing number of candidates are not acceptable as the intended value cannot be determined clearly. A sharp pencil should be used for the plots and for the line so that accurate drawing may be achieved and errors easily corrected.

Scales were usually sensible. Only a few candidates had used impractical scales, with intervals of 0.3 or 0.6. A number of candidates lost a mark by plotting points on a line when they should have clearly been in the middle of the gap between two lines.

Many candidates produced a fine, straight, well-judged line of best-fit and only a very few failed to join points together. There was a tendency by some to force the line incorrectly through the origin or to ignore ‘inconvenient’ points, treating them as outliers when they clearly were not. Candidates should be aware that only points lying well outside the trend of the other plots should be treated in this way and marked as such.

(c) Most candidates were able to interpret the intercept correctly.

(d) The majority of candidates gave the correct measurement for the length of the extended spring and most went on to give a value for *W* which was in the expected range. However, construction lines shown on the graph were not always accurate or clear, and were sometimes missing.

(e) Many recognised that the given answer was expressed to an excessive number of significant figures but often gave explanations which lacked clarity or detail. The majority of correct responses referred to the data in the table being given to only two or three significant figures or pointed out that four significant figures could not be read sensibly from the graph.

Question 3

A large percentage of even the strongest candidates found this question challenging.

(a) (i) Most candidates constructed a series circuit but quite a number showed the circuit symbols incorrectly. Many candidates confused the symbol for a variable resistor with a thermistor or simply drew a resistor, omitting the strike-through arrow. Only a small minority of candidates were confused as to where to construct their circuit.

(ii) The most common correct variable chosen was the distance between the fan and the turbine blades. However, this part of the question was the least well done by most candidates, many answers referring to the potential difference across the power supply or the current in the fan, ignoring the fact that this was the independent variable in the experiment and so would not remain constant.

(b) Many were able to achieve some credit for this question but a number referred, as in **(a)(ii)**, to various electrical quantities rather than aspects of the turbine, such as length, area, angle or number of blades.

Question 4

Many candidates obtained their best performances on this question, but a number had difficulty with interpretation of results.

(a) Candidates generally appreciated that voltmeters are to be connected in parallel. However, many did not recognise the need for connections to include the whole length of the wire. The simplest diagram with a voltmeter connected in parallel between the vertical arms of the circuit was seen in very few responses.

(b) Nearly all candidates gained credit here, with only a very few reading the ammeter as 3.8 A instead of 0.38 A.

(c) Most candidates were able to draw accurate arrows to the correct positions on the scales.

(d) Most candidates gave correctly calculated responses to two or, more often, three significant figures. Units were sometimes neglected and some credit was lost because of this.

(e) (i) Many candidates were able to recognise that the student’s suggestion was correct and gained credit, provided that values from the results were given in support of their answer. It was clear, however, that a number of candidates did not appreciate that the values were ‘close enough’ and expected them to be identical for the suggestion to be correct.

Some candidates failed to gain full credit by not justifying their statement with an explanation of ‘within the limits of experimental accuracy’ or by referring to theory rather than the results.

(ii) Correct responses stated that R_3 was 1/3 R_1, following the pattern from the simple relationship between R_2 and R_1 suggested in **(e)(i)**. There were, however, a number of incorrect answers which referred to the theory of parallel circuits in general without mentioning the resistances in the question. A suggested relationship of 'approximately 1/3' was also unacceptable.

Question 5

Many candidates were able to do well on this question but quite a number had difficulties with some aspects.

(a) Nearly all candidates were able to construct a normal in the correct place.

(b) The majority of candidates drew a thin, continuous, straight line through the two pin positions. Candidates do need to be reminded to use a sharp pencil and take care with their diagrams as the quality and accuracy of lines is tested in this type of question.

Most candidates had a correct measurement for *a*, but there was quite a variation for *b*, where the expected range was chosen to reflect the accuracy of candidates' drawing.

(c) Nearly all candidates earned credit for a correctly calculated value of refractive index, based on the results given in the previous part of the question. Where errors were made, it was generally for attaching a unit to *n*.

(d) The most common precautions identified were the use a sharp pencil, ensuring that pins were vertical or viewing the pins from the base. A small number of candidates, given the dimensions of the diagram in the question, suggested an acceptable pin separation of over 5 cm.

Some candidates incorrectly suggested the use of a dark area or turning off other sources of light, not appreciating the practical details of how the investigation would be conducted.

(e) Many candidates were able to identify that the value would be less reliable but fewer of these knew it was due to smaller measurements. Only a very small number went on to associate this with a greater percentage uncertainty.

A number of candidates incorrectly thought there would be less refraction.