PHYSICS

Paper 0625/11
Multiple Choice

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

General Comments

In this paper **Questions 6** and **13** were particularly well-answered, but **Question 10** caused difficulty for many.

Comments on Specific Questions

Question 10

The topic for this question was the pressure due to a certain depth of water, and few candidates appreciated that this would not vary with the shape of the container. Although the question wording was carefully chosen to emphasise what was required, the popularity of option **B** suggested that many candidates were thinking about the pressure on the surface *beneath* the containers rather than that *caused by the water on the base* of the containers.

Question 15

Although this question on thermometer scale fixed points was generally well answered, a significant proportion, especially of the lower-achieving candidates, thought that these points were the beginning and end points of the thermometer scale.

Question 20

Many of the lower-achieving candidates did not know that frequency is constant when light is refracted, and appeared to be guessing, with all options proving popular.

Question 21

Many of the lower-achieving candidates thought that airport security scanners used infra-red rays rather than X-rays.

Question 23

This question concerned the image produced by a converging lens and was less well answered than many others. All options were popular, suggesting that candidates may have been guessing; many of the lower achieving candidates opted for **C**, showing the object placed at a focus of the lens.

Question 25

Many of the lower-achieving candidates were unable to average the set of results in this question, and opted for distractor **B**.

Question 28

Most responses to this question were correct, but those candidates unfamiliar with the meaning of the term ‘electromotive force’ generally opted for **A**, thinking that e.m.f. was a force and so must be measured in newtons.

Question 30

This question involved a parallel circuit, with one branch containing a switch that was initially open. A common error was to think that closing the switch increased the total circuit resistance to $5.0\,\Omega$, leading to a choice of option **A**.

Question 32

The potential divider caused problems for a significant proportion of the candidates, with almost as many choosing **D** as **C**. This suggests uncertainty over the correct application of the concept of a ratio of 1 to 10.

Question 34

It was common for candidates to answer that higher voltages in transmission cables cause larger currents.

PHYSICS

Paper 0625/12
Multiple Choice

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

General Comments

In this paper **Questions 1, 2, 4, 17** and **23** were particularly well-answered, and no question caused particular difficulty.

Comments on Specific Questions

Question 9

The topic for this question was the pressure due to a certain depth of water, and few candidates appreciated that this would not vary with the shape of the container. Although the question wording was carefully chosen to emphasise what was required, the popularity of option **B** suggested that many candidates were thinking about the pressure on the surface *beneath* the containers rather than that *caused by the water on the base* of the containers.

Question 13

Although this question on thermometer scale fixed points was generally well answered, a significant proportion, especially of the lower-achieving candidates, thought that these points were the beginning and end points of the thermometer scale.

Question 19

This question involved a parallel circuit, with one branch containing a switch that was initially open. A common error was to think that closing the switch increased the total circuit resistance to $5.0\,\Omega$, leading to a choice of option **A**.

Question 20

It was common for candidates to answer that higher voltages in transmission cables cause larger currents.

Question 24

The potential divider caused problems for a significant proportion of the candidates, with almost as many choosing **D** as **C**. This suggests uncertainty over the correct application of the concept of a ratio of 1 to 10.

Question 25

A significant number of candidates thought that the low-rated fuse would not only blow, but also cause damage to the kettle.

Question 27

Many of the lower-achieving candidates thought that airport security scanners used infra-red rays rather than X-rays.

Question 28

Many of the lower-achieving candidates did not know that frequency is constant when light is refracted, and appeared to be guessing, with all options proving popular.

Question 29

Many of the lower-achieving candidates were unable to average the set of results in this question, and opted for distractor **B**.

Question 32

Most responses to this question were correct, but those candidates unfamiliar with the meaning of the term 'electromotive force' generally opted for **A**, thinking that e.m.f. was a force and so must be measured in newtons.

Question 35

This question concerned the image produced by a converging lens and was less well answered than many others. All options were popular, suggesting that candidates may have been guessing; many of the lower achieving candidates opted for **C**, showing the object placed at a focus of the lens.

PHYSICS

Paper 0625/13
Multiple Choice

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

General Comments

In this paper **Questions 2**, **8**, **11** and **21** were particularly well-answered, but **Question 32** caused difficulty for many.

Comments on Specific Questions

Question 3

This question concerned average speed, and was generally well answered. Those candidates who wrongly chose option **B** may not have taken account of ‘in the air’ in the question, despite this phrase being printed in bold.

Question 6

Although the vast majority of responses to this question on density were correct, some of the lower-achieving candidates did not subtract the mass of the empty measuring cylinder, therefore opting for **D**.

Question 9

This was generally a well answered question; however some of the lower-achieving candidates chose option **C**, possibly having not taken account of the emboldened 'within the battery'. Candidates should always pay particular attention to any text written in **bold**.

Question 12

This question was not answered correctly by a sizeable proportion of candidates, with many thinking that a narrower tube would cause *h* to increase.

Question 14

Responses to this question on evaporation showed some confusion over cause and effect, with some candidates opting for **B**, possibly due to a misconception that energy would be conducted *away* from the water through the metal dish, rather than *into* the water, as would happen once the water started to cool.

Question 17

A significant number of candidates thought that thermal conduction only occurred in solids, neglecting substances such as mercury, or indeed any other molten metals.

Question 23

This question concerned the image produced by a converging lens and was less well answered than many others. Many candidates opted for **B**, an object position that would produce an enlarged image.

Question 25

Many of the lower-achieving candidates were unable to average the set of results in this question, and opted for distractor **B**.

Question 29

The most common mistake was to calculate the p.d. across the $30\,\Omega$ resistor and giving this as the answer, rather than subtracting it from $6.0\,\text{V}$.

Question 32

The potential divider caused problems, with all options proving popular.

Question 33

A significant number of candidates thought that the low-rated fuse would not only blow, but also cause damage to the kettle.

Question 34

A significant number of candidates did not appreciate that changing both the direction of the current and that of the magnetic field would have no effect on the direction of the force produced on the wire.

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 the Examiner is expecting. For example, on a two mark question the Examiner is expecting two distinct points, not two versions of the same point.

Candidates must read the question carefully and make sure they follow the rubric of the question. In particular, candidates must not try to maximise their chances by giving more than the required number of answers to a question. If two alternative answers are given, one correct and the other incorrect, the candidate will almost always score no credit. A useful tip for candidates is that they should read the question through very carefully, both before and after writing their answer.

It was noted that a number of candidates had underlined the question command word and the key terms in the question. This may help candidates to identify what the question wants them to write about.

Candidates are advised to read carefully through their responses 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. The Examiner may be able to give credit 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 the Examiner to give any reward for the question.

General Comments

A high proportion of candidates had clearly been well taught and 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 energy transfers, the interpretation of melting and heat transfer and nuclide notation 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, their responses were confused and 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 marks in the examination.

An occasional candidate had written out answers in pencil before tracing over them in ink. This should be strongly discouraged; not only is it a waste of the candidate's time but it can lead to an answer which is less legible than it would otherwise be. Candidates should be encouraged to present their answers as carefully and neatly as possible. Whilst examiners are generous in interpreting spelling mistakes and awarding due credit they will not accept responses that try to have two attempts e.g. if the answer required is refraction, words such as 'reflaction' are not credited as the examiner cannot be certain of the candidate's intended meaning.

The majority of candidates indicated, by their knowledge and skills, that they were correctly entered for this Physics Core paper. However, a significant minority of candidates found the subject matter and level of some questions very easy, and they may have benefited from being prepared and entered for the Extended Theory paper.

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.

This is a paper where all of the questions are compulsory. Candidates did not seem to find any difficulty in completing it in the allocated time and relatively few left answers to questions blank.

Comments on specific questions

Question 1

(a) The majority of candidates struggled with this fairly straightforward description. Only the highest achieving candidates were able to give three valid points about how the length of the spring could be measured accurately.

(b) Most candidates gained full credit for this, but a number went on to divide the correct answer by two.

(c) Many candidates did not show a firm understanding of the concept of the resultant force, and answers involving addition of the two forces were common. Many candidates did not gain credit for the direction, with answers such as north, south, forwards and towards.

Question 2

(a) Many candidates answered correctly, but some divided by 1000 or multiplied by 100.

(b) A significant number of candidates either did not remember or were unable to correctly transpose the equation for density.

Question 3

(a) Most candidates scored partial credit for this question. The most common mistake was having distance and time in the first sentence.

(b) Many candidates gave responses that did not properly address what was being asked in the question. Only the higher achieving candidates gave suggestions about energy being transferred as thermal energy to the surroundings.

Question 4

(a) This question was not well answered. Some candidates scored the first marking point, but many lost credit by stating that the substance was melting in the region AB. Very few candidates went on to correctly state what was happening in the other two regions.

(b) Only the highest achieving candidates recognised that ice needed to take thermal energy from the water in order to melt.

(c) **(i)** Most candidates gained credit for a correct statement of what would happen, but only the highest achieving candidates gave valid explanations for the increase in temperature.

(ii) In this part of the question, most candidates scored quite well, with clear explanations about the steam condensing to increase the mass of the water.

Question 5

(a) A large majority of candidates gained credit for their answers.

(b) Most candidates correctly applied the equation linking speed, distance and time. Some candidates did not transpose the equation correctly, and a significant number did not divide their answer by two.

(c) Most of the candidates who had given good answers in **(b)** went on to gain credit here.

(d) Many candidates gave correct differences, but a number only gave one difference, or thought they had given two differences by giving the converse of their first response, e.g. 1. sound waves are longitudinal waves, 2. light waves are transverse waves.

Question 6

(a) Many candidates gained full credit. A common mistake in **(ii)** was not to give the result of their test, e.g. stating "bring the rod close to some small pieces of paper", but not stating that the paper would be attracted if the rod was charged.

(b) This question was generally well answered, with many candidates providing clear suggestions for why the lady experiences an electric shock.

Question 7

(a) (i) Very few candidates correctly indicated the focal length of the lens.

(ii) This part of the question scored quite well, but many candidates were let down by a lack of precision in their drawing. A common mistake was not showing a correct refraction at either the centre of the lens or at both surfaces.

(b) Many candidates did not realise that, in order to see a focused image, the screen should be placed at I.

(c) (i) Only the highest achieving candidates were able to state that the image would move closer to F_1 or the lens.

(ii) Many candidates correctly stated that the size of the image would be diminished.

Question 8

(a) Many candidates gave the correct name for the component. Common errors included omission of variable, or calling the component a fixed resistor. Only the highest achieving candidates went on to gain the credit in **(ii)** for a correct description of the function of the variable resistor in the circuit.

(b) Most candidates gained full credit, although some of the less well-achieving candidates often gained credit in **(i)** but gave an incorrect unit in **(ii)**.

(c) Most candidates correctly applied the equation for calculating the combined resistance of two resistors in series.

(d) (i) Many candidates scored full credit. The most common errors were either drawing a line through the resistor symbol, or short circuiting the parallel combination.

(ii) The majority of candidates gained credit.

Question 9

(a) Many candidates gained full credit, but a significant number confused core with coil and iron with steel or copper.

(b) Many candidates gained the full credit for this calculation. However, a significant number scored zero through simply writing down an incorrect answer with no calculation shown. Candidates should be encouraged to show their working in all calculations in order that some credit can be given for partially correct responses.

(c) The highest achieving candidates scored full credit, but the majority did not give enough detail, about either fewer turns or lower voltage, in their explanations.

(d) The majority of candidates gave correct answers.

Question 10

(a) The majority of candidates gained credit.

(b) Few candidates stated that the screen would glow to indicate the presence of cathode rays.

(c) This question was not well answered by candidates. There were very few completely correct responses.

(d) Only the highest achieving candidates recognised that Y_2 needed to be made positive and Y_1 negative in order to deflect the cathode rays to the top of the screen.

Question 11

(a) The majority of candidates were able to identify the electron, but there was considerable confusion between proton and neutron.

(b) The majority of candidates scored the credit for this marking point.

(c) Only the highest scoring candidates gave the correct nuclide notation for deuterium and tritium. Many candidates had the notation inverted.

Question 12

(a) Many candidates were able to correctly plot the points and draw a line of best fit for the points. However, a significant number lost credit through careless plotting or line drawing.

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

(ii) Only the highest scoring candidates were able to determine the "half-life" of dice. A common error was to simply state half the number of throws shown on the graph, i.e. seven.

(iii) Only a few of those who determined the "half-life" of dice were able to give a correct suggestion and explanation for this question.

PHYSICS

Paper 0625/22
Core Theory

Key Messages

In order to perform well on this paper, candidates need to have learnt all sections detailed in the Core syllabus and be prepared to answer questions that use this learning in a variety of contexts.

Candidates need to read questions carefully and note the space available and the number of marks allocated for responses, as these provide clear information as to the type of response expected by the Examiner. For example, concise responses are expected in questions that have one line and one mark allocated. Candidates also need to ensure that they answer questions with unambiguous responses to secure full credit.

In calculations, candidates must set out and explain the stages in their working clearly. Examiners will often be able to give partial credit to candidates who clearly show the stages in their working even if the final answer is incorrect. Candidates who give only the answer risk the loss of all possible credit if their answer is incorrect.

General Comments

A high number of candidates scored well on this paper indicating clearly that many candidates had been well taught and prepared for this paper. Some areas of the syllabus were better known than others; in particular the questions on evaporation and critical angle proved to be challenging for all but the highest scoring candidates. A small number of the highest scoring candidates may have benefited from being prepared and entered for the Extended Theory paper.

Most candidates had been well prepared for questions that involved calculations. Candidates were able to use and apply equations such as the transformer equation in standard situations. However, in other calculations requiring candidates to apply their knowledge to a new situation, some candidates became confused and displayed a lack of depth of understanding that resulted in incorrect responses. More practice in applying equations in a variety of contexts would better prepare candidates for the examination.

A small but significant number of candidates left parts of a question unanswered, suggesting that their knowledge and understanding was less than secure. 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 to rush their responses in order to complete the paper. All candidates would be well 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.

Comments on specific questions

Question 1

(a) Few candidates gained full credit. A common misconception was that there are no forces acting on an object when in equilibrium.

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

(ii) A significant number gave ambiguous or vague responses in terms of the balance tilting or no longer being in equilibrium.

(iii) Many candidates gained full credit. Some candidates lost credit due to an incorrect or missing unit.

Question 2

(a) Only the higher scoring candidates answered this question correctly. A variety of responses were seen that involved the two numbers provided in the question being added, subtracted, divided or multiplied.

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

(ii) This question was well answered by the higher scoring candidates. Many candidates gave partially correct responses but had not appreciated that the distance travelled would require the average speed or area under the graph.

Question 3

(a) Correct responses were usually stated.

(b) There were many correct responses. Some candidates gained only partial credit since one of their answers replicated their other acceptable response, for example, fossil fuels being given alongside coal, gas or oil.

(c) (i) There were many good answers from middle and higher scoring candidates. Incorrect responses included either kinetic, tidal or wave energy.

(ii) Many candidates scored credit for at least one of the available marking points.

Question 4

(a) A correct response was usually given.

(b) This question and the question following were not well answered. In many cases candidates had not appreciated that for evaporation to take place water molecules escape from the surface after having gained sufficient energy. Common errors included stating the process of evaporation rather than describing it. Other vague responses in terms of kinetic energy and convection, and incorrect responses in terms of expansion of molecules, were also seen.

(c) Only the highest scoring candidates obtained any credit for their responses to this question. Many candidates repeated incorrect responses given in part **(b)**.

Question 5

The majority of candidates scored at least three of the available five marking points for this question and many gained full credit. The lowest scoring candidates failed to gain any credit, demonstrating some commonly held misconceptions.

Question 6

(a) (i) There were many correct responses resulting in both marking points being credited. Responses that did not gain credit included placing the thermometer in "a freezer "or in "melting water".

(ii) A correct response was usually stated.

(b) A correct response was usually stated.

(c) This question was not well answered; candidates were very rarely able to identify two physical properties that changed with temperature. A small number gained credit for one of the available two marking points for a response that often included pressure of a gas or the density of a liquid.

Question 7

(a) (i) There were many correct responses. A small but significant number of candidates gave the incorrect response of metre rule.

(ii) A correct response was given by nearly all candidates.

(b) The majority of candidates gave responses worthy of credit. In some cases credit was not given for vague responses that suggested lack of attention from the timer or that runners had made a false start.

(c) (i) The majority of candidates obtained full credit for their responses to this question.

(ii) Few candidates gave acceptable responses to this question. The most common responses were vague answers referring to runners not running at constant speed or runners running faster than average speed. Vary rarely was any reference made to the runner accelerating from the start.

(d) (i) This question was not well-answered. The answers given ranged from 10 cm to 2 km. There were relatively few answers within the acceptable range.

(ii) Acceptable responses were seen from a good number of candidates suggesting that they may have been involved in this type of activity. However, many gave incorrect responses in terms of when the pistol was heard.

Question 8

(a) This question was answered well by only the very high achieving candidates. Responses suggested these may have had practical experience of observing light rays travelling though different mediums.

(b) Lower and middle ability candidates generally only gained credit for showing the refracted ray deviated away from the normal. The highest scoring candidates gained credit for two or three of the marking points, but there were very few instances where full credit was obtained.

Question 9

(a) A correct response was usually given.

(b) (i) This question was well answered by all but the lowest achieving candidates.

(ii) Few candidates gained full credit for this question. A small number realised that the voltage across CD would be zero but fewer gave responses indicating that they were aware of the need for an a.c. supply.

Question 10

(a) A correct response was usually given.

(b) Both components were correctly labelled by all but the weakest candidates. A small number of candidates did not complete the labelling.

(c) Middle and higher scoring candidates usually obtained full credit. A common error from lower scoring candidates was “resistor” for the name of the component.

(d) This question was generally well completed by the highest scoring candidates. There were many candidates, however, who mis-plotted at least one of the points. Many candidates did not include a graph line for the points plotted. Many of those that drew the line lost credit for joining the plots rather than drawing a best-fit line. The majority of candidates were able to obtain a value for the resistance, although not all had used their graph.

Question 11

(a) Few candidates gave the expected answer of background radiation.

(b) The majority of candidates did not take account of background radiation and so gained credit for only two of the three marking points for this question.

(c) Very few candidates gave the correct answer to the first part. A common response was 0. Candidates generally appreciated that the aluminium would stop the β radiation.

Question 12

This question was generally well answered by all but the lowest scoring candidates.

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.

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Question 1

(a) The majority of candidates struggled with this fairly straightforward description. Only the highest achieving candidates were able to give three valid points about how the length of the spring could be measured accurately.

(b) Most candidates gained full credit for this, but a number went on to divide the correct answer by two.

(c) Many candidates did not show a firm understanding of the concept of the resultant force, and answers involving addition of the two forces were common. Many candidates did not gain credit for the direction, with answers such as north, south, forwards and towards.

Question 2

(a) Many candidates answered correctly, but some divided by 1000 or multiplied by 100.

(b) A significant number of candidates either did not remember or were unable to correctly transpose the equation for density.

Question 3

(a) Most candidates scored partial credit for this question. The most common mistake was having distance and time in the first sentence.

(b) Many candidates gave responses that did not properly address what was being asked in the question. Only the higher achieving candidates gave suggestions about energy being transferred as thermal energy to the surroundings.

Question 4

(a) This question was not well answered. Some candidates scored the first marking point, but many lost credit by stating that the substance was melting in the region AB. Very few candidates went on to correctly state what was happening in the other two regions.

(b) Only the highest achieving candidates recognised that ice needed to take thermal energy from the water in order to melt.

(c) (i) Most candidates gained credit for a correct statement of what would happen, but only the highest achieving candidates gave valid explanations for the increase in temperature.

(ii) In this part of the question, most candidates scored quite well, with clear explanations about the steam condensing to increase the mass of the water.

Question 5

(a) A large majority of candidates gained credit for their answers.

(b) Most candidates correctly applied the equation linking speed, distance and time. Some candidates did not transpose the equation correctly, and a significant number did not divide their answer by two.

(c) Most of the candidates who had given good answers in **(b)** went on to gain credit here.

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(a) Many candidates gained full credit. A common mistake in **(ii)** was not to give the result of their test, e.g. stating "bring the rod close to some small pieces of paper", but not stating that the paper would be attracted if the rod was charged.

(b) This question was generally well answered, with many candidates providing clear suggestions for why the lady experiences an electric shock.

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(a) (i) Very few candidates correctly indicated the focal length of the lens.

(ii) This part of the question scored quite well, but many candidates were let down by a lack of precision in their drawing. A common mistake was not showing a correct refraction at either the centre of the lens or at both surfaces.

(b) Many candidates did not realise that, in order to see a focused image, the screen should be placed at I.

(c) (i) Only the highest achieving candidates were able to state that the image would move closer to F_1 or the lens.

(ii) Many candidates correctly stated that the size of the image would be diminished.

Question 8

(a) Many candidates gave the correct name for the component. Common errors included omission of variable, or calling the component a fixed resistor. Only the highest achieving candidates went on to gain the credit in **(ii)** for a correct description of the function of the variable resistor in the circuit.

(b) Most candidates gained full credit, although some of the less well-achieving candidates often gained credit in **(i)** but gave an incorrect unit in **(ii)**.

(c) Most candidates correctly applied the equation for calculating the combined resistance of two resistors in series.

(d) (i) Many candidates scored full credit. The most common errors were either drawing a line through the resistor symbol, or short circuiting the parallel combination.

(ii) The majority of candidates gained credit.

Question 9

(a) Many candidates gained full credit, but a significant number confused core with coil and iron with steel or copper.

(b) Many candidates gained the full credit for this calculation. However, a significant number scored zero through simply writing down an incorrect answer with no calculation shown. Candidates should be encouraged to show their working in all calculations in order that some credit can be given for partially correct responses.

(c) The highest achieving candidates scored full credit, but the majority did not give enough detail, about either fewer turns or lower voltage, in their explanations.

(d) The majority of candidates gave correct answers.

Question 10

(a) The majority of candidates gained credit.

(b) Few candidates stated that the screen would glow to indicate the presence of cathode rays.

(c) This question was not well answered by candidates. There were very few completely correct responses.

(d) Only the highest achieving candidates recognised that Y_2 needed to be made positive and Y_1 negative in order to deflect the cathode rays to the top of the screen.

Question 11

(a) The majority of candidates were able to identify the electron, but there was considerable confusion between proton and neutron.

(b) The majority of candidates scored the credit for this marking point.

(c) Only the highest scoring candidates gave the correct nuclide notation for deuterium and tritium. Many candidates had the notation inverted.

Question 12

(a) Many candidates were able to correctly plot the points and draw a line of best fit for the points. However, a significant number lost credit through careless plotting or line drawing.

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

(ii) Only the highest scoring candidates were able to determine the "half-life" of dice. A common error was to simply state half the number of throws shown on the graph, i.e. seven.

(iii) Only a few of those who determined the "half-life" of dice were able to give a correct suggestion and explanation for this question.

PHYSICS

Paper 0625/31
Extended Theory

Key messages

When a question has parts, for example **(i)**, **(ii)** and **(iii)**, the parts are all continuations of the same question topic. This applies to all types of question. Candidates do not necessarily, therefore, need to apply fresh thinking to each question part. For example, if a question is a numerical one, part **(i)** may require the use of a recalled formula. Candidates might then anticipate that the subsequent parts may be further developments based on this response. Comments on two questions in the paper refer to this idea.

Numerical questions sometimes provide data in units with a multiplier, such as km, kV or mW. In order to use such data in calculations, the safest option is usually to convert these units into the corresponding basic unit, m, V or W, and to give the answer in a basic unit.

General Comments

Candidates in general showed greater confidence in answering questions based on the General Physics section of the syllabus than on other topics, which might benefit from greater teaching time or revision.

Many candidates produced very commendable work in numerical questions, although unit errors were not uncommon, particularly where the question included a multiplier. In general the candidates performed less well with extended writing questions, where the requirements of the question were often not adhered to.

Comments on Specific Questions

Question 1

(a)(b) Many candidates identified all six graphs correctly. Where a single error was made, it was usually in identifying the graph F as representing stationary motion rather than constant speed.

(c) (i) Errors in recalling the required formula and performing the calculation were rare. However, the unit was frequently stated as m/s rather than m/s^2.

(ii) In **1**, many candidates had not appreciated that at the point when the maximum speed had been reached the acceleration must have ceased. The answer was consequently stated by many candidates as $10\,m/s^2$ rather than zero. In **2**, the answer needed to express in some way that there was no resultant force. Some candidates, who had correctly stated the acceleration as zero, did not convey this idea correctly.

Question 2

(a) (i) A large majority of the candidates calculated the gravitational potential energy correctly. Some omitted the unit.

(ii) This was an example of the point referred to in the Key Messages. The expected approach to find the speed involved equating the kinetic energy to the gravitational potential energy calculated in **(i)**. A few candidates knew the non-syllabus formula $v^2 = u^2 + 2\,as$ and used it successfully. Other approaches attempted by candidates failed to make any headway. However, it was pleasing to reward many correct answers.

(b) Totally correct answers were rare. The best of these were given by candidates who realised that the original value of the gravitational potential energy and its conversion to kinetic energy continued to apply.

Question 3

(a) (i) A significant number of candidates did not refer correctly to the difference between the pressure outside and the pressure inside the can.

(ii) A large number of candidates wrote down the correct formula, but then lost credit by omitting to subtract the pressure inside the can from the atmospheric pressure.

(b) (i) A number of ways of expressing the equality of the pressures in the two limbs were seen and accepted.

(ii) Candidates who had answered **(i)** correctly, usually recognised the applicability of $p = h\rho g$ in **1** and **2**, and answered both parts correctly and gave the correct units. Some candidates, having answered **1** correctly and seeing that a calculation of density was required in **2**, attempted to use $\rho = m / V$ and got nowhere. The point made in the Key Messages again applies.

Question 4

(a) Candidates were required to state the measurements that were needed, not to describe an experiment. Those who wrote a description were not penalised, but used time unnecessarily. The common reasons for loss of credit were to refer to measuring the temperature rise, rather than the initial and final temperatures, and the omission of the measurement of the time of heating.

The stated value of the power of the heater or measurements of the p.d. and the current used were equally acceptable. Some candidates did not state a symbol for each of the measurements, but were not penalised as a result. Credit may have been lost in **(b)** however if non-standard symbols were used there and not previously defined.

(b) In completing the formula for specific heat capacity, most candidates gave an acceptable version of the denominator. Many, however, simply gave the numerator as Q or H rather than Pt or IVt, depending on their measurements in **(a)**. Words rather than symbols were credited.

(c) Most answers referred to a lack of insulation leading to more heat loss, but few added that this would result in a smaller temperature rise, or to more heat input being needed for the same temperature rise.

Question 5

(a) (i) A significant number of candidates were unable to successfully explain what is meant by the terms longitudinal and transverse in referring to waves. Candidates needed to be clear that it is particles or molecules that vibrate or oscillate, and that they do this in the direction of the wave travel, or perpendicular to it, as appropriate.

(ii) Most candidates could state correct examples.

(iii) Many candidates received some credit for stating the formula $v = f\lambda$, but this was often wrongly transposed. If working had been carried out with the speed in km / s, the answers that followed were often incorrectly given in m rather than in km. The advice in the second Key Message should be heeded.

(b) The majority of candidates gave a correct statement and an acceptable explanation of the effect of removing air from the chamber.

Question 6

(a) Almost all the candidates gained credit for at least 3 of the 4 possible marking points. Some candidates had little idea about projecting the diverging reflected rays back to locate the image. Others clearly worked from the fact that they knew the location of the image and proceeded accordingly, which was acceptable.

(b) Questions on the refraction of wavefronts are probably more familiar to candidates. Very few seemed to appreciate that this was a wave version of the ray diagram about reflection in **(a)**. Many candidates did not place the image point behind the barrier correctly or draw the reflected wavefronts. Some who succeeded in placing the point correctly then drew wavefronts behind the barrier.

Question 7

(a) (i) The diagram needed to show both the spacing and randomness of the helium molecules. The former requirement was generally met, but some sketches showed too many molecules in lines for randomness to be clearly demonstrated.

(ii) A good proportion of the answers satisfactorily compared the size of the attractive forces, but few of these explained the size of the forces with respect to the separation of the molecules.

(b) (i) A calculation using an expression of Boyle's Law was required. With correct substitution, an answer of $0.15\,m^3$ could be obtained for the new total volume of gas. Most candidates divided this volume by the volume of each balloon to arrive at a result of 50 balloons, gaining credit for 2 of the marking points. For the correct final answer of 48 balloons, and to achieve full credit, the volume of gas in the cylinder needed to be subtracted from $0.15\,m^3$ before the division. Only a minority of candidates obtained credit for this final marking point.

(ii) The majority of candidates gained full credit.

Question 8

(a) (i) (ii) Few candidates could identify a rectifier or diode for **(i)**. Rather more could give the answer 'frequency' for **(ii)**.

(b) (i) (ii) The correct formulae for both parts were usually quoted and appropriate numbers substituted. Because of the use of mA in the in the question, many candidates lost credit for incorrect units in one or other part.

(c) Each of the given choice of quantities was underlined with approximately equal frequency, suggesting that many candidates were guessing at the answer.

Question 9

(a) The correct response of background radiation was only seen in a minority of the scripts.

(b) Answers in general gave isolated facts about α-radiation, without addressing the successive stages described in the second paragraph of the question. Many of even the high scoring candidates did not achieve full credit for this question.

(c) (i) Almost all candidates, knowing that α-particles have a positive charge, sketched a downward sloping curve, and gained some credit. Fewer candidates achieved full credit by also showing the curve beginning at the point where the beam entered the space between the plates.

(ii) The majority of the candidates achieved credit for their answers.

Question 10

Most candidates could give the response that the remaining lamps stay on, but some of their explanations only amounted to saying 'because they are in parallel'.

(b) (i) A significant number of candidates had evidently examined the circuit with insufficient care, and lost some credit.

(ii) This question was found challenging by many candidates, who were unable to suggest a sensible use of such a circuit, often suggesting, for example, that if one switch fails the other would continue to work.

Question 11

(a) Many candidates either did not realise that the given process involved electromagnetic induction, or could not recall the name of the process.

(b) (i) A large majority of the candidates stated that the pointer deflects, and were awarded some credit. Fewer gained credit for the second marking point by stating that the pointer then returns to zero.

(ii) Most candidates were given some credit for suggesting a greater or faster deflection of the pointer, but fewer went on to say that the deflection was in the opposite direction.

PHYSICS

Paper 0625/32
Extended Theory

Key Messages

Candidates must read the question very carefully to ensure that they answer the question that is being asked, not the one the candidate thinks has been asked. Often a question is about a familiar situation but the actual question is different from that expected by the candidate.

Similarly, 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 **Question 3(b)** about areas on a speed-time graph and in **Question 9(a)** about a transformer.

Particularly in questions requiring extended calculation, candidates must set out and explain their working correctly. Often a candidate uses an unusual method with an unclear explanation, or gives no working or poor working. If this leads to the correct answer, the Examiner may be able to give some credit. When an error is made in the middle of such work, it is usually impossible for the Examiner to see anything of merit so no credit can be awarded. This was especially so in **Question 8(b)(iii)** about electrical power.

General Comments

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

Many candidates tend to think less rigorously and logically in non-numerical questions than in numerical questions.

Generally candidates followed the rubric of the questions. However, candidates must not try to maximise their chances by giving more than one answer to a question. If two answers are given, one right and the other incorrect, the candidate will almost always gain no credit.

Many candidates would benefit from more practice in applying their knowledge in unfamiliar situations. Some candidates evidently knew the equations, and could apply them to fairly standard situations, but displayed a lack of breadth of understanding of their use in contexts outside of a Physics laboratory.

The English language ability of the vast majority of candidates was adequate for the demands of this paper. A small minority, however, presented answers that were unclear.

It is good practice to give final answers to the same number of significant figures as the data in the question (or one more). Rounding errors can sometimes be introduced, however, if rounding is carried out too early in a multi-stage calculation. Fractions should not be used in final answers. The use of units by stronger candidates was good, but overall there were a significant number of instances of omitted or incorrect units, especially in **Question 4(a)(ii)**.

Comments on Specific Questions

Question 1

Throughout this question many of the lower achieving candidates seemed to have a misapprehension about equilibrium, stating that the force or moment in one direction had to be greater than the force or moment in the other direction in order to achieve equilibrium. Often this error was accompanied by the use of the word *overcome*, which is unlikely to be helpful in considering the situation.

(a) Many candidates did not recall both conditions necessary for a system of forces acting on a body to be in equilibrium. A common mistake was merely to state that the upward forces were equal to the downward forces.

(b) (i) Many candidates appreciated that $W = P+Q$ was required but then simply repeated the stem of the question, which did not gain any further credit.

(ii) Most candidates gained some credit for either a correct statement about moments or a clear comment about the distances of the forces P and W from the pivot. Very few, however, gained full credit for making both points.

(c) This was well answered by most candidates.

Question 2

(a) Most candidates gained full credit. In **(ii)** there was frequent confusion between mass and weight, which led to inaccurate statements.

(b) Most of the higher achieving candidates correctly calculated the answer. Common errors occurred in obtaining the values for mass and the resultant force from the data supplied, such as addition instead of subtraction of forces or failing to convert weight to mass, A considerable number of candidates did not rearrange the equation $F = ma$ correctly. Candidates should always consider whether the value of their final answer is feasible in the context of the question. Many candidates had final answers in the order of the acceleration of free fall, such as $8\,m/s^2$ or $12.5\,m/s^2$, which is not feasible for a tanker lorry.

Question 3

(a) Very few candidates answered this part correctly. Even the majority of the higher achieving candidates did not appreciate the meaning of the gradient of a graph, often quoting 0, which was the value of speed at B.

(b) Many candidates gained full credit. A common omission was not stating that the shaded areas were equal. Many of the lower-achieving candidates gave descriptions of the motion of the rocket as relating to the lines on the speed-time graph rather than considering the areas between the lines and the axes.

(c) This part was better answered and many candidates gained part or full credit. The most frequent shortcoming was not showing that the rocket with a parachute would take more time to descend.

Question 4

(a) (i) The vast majority of candidates gained full credit. Some candidates correctly quoted the kinetic energy equation but failed to square v in their calculation.

(ii) Most candidates gained full credit, but an appreciable number gave the unit of power as joules and there was sometimes confusion in applying the efficiency equation.

(b) Most candidates correctly evaluated the density of the air.

(c) There were many excellent answers giving clear descriptions, which scored full credit. Many candidates, however, gave an answer in terms of energy transfers, which did not address the question.

Question 5

(a) The expected response was a random arrangement of molecules touching or very close to each other. Many candidates gained full credit or part credit for drawing a random arrangement. The most common errors were to show either a regular lattice array, as of a solid, or to have the molecules widely spaced, as of a gas. A few candidates drew long chain molecules or clusters of two or three circles in contact, perhaps erroneously drawing the atoms of gas molecules.

(b) (i)(ii) Most candidates recognised that the temperature would decrease, and gave good explanations in terms of the escape of more energetic molecules.

(iii) This was generally well answered although many of the lower achieving candidates attempted some specific heat capacity calculation or rearranged the equation incorrectly.

(iv) The majority of candidates gained full credit with correct ways of reducing the rate of evaporation.

Question 6

(a) (i)(ii) Most candidates gained credit for identifying the correct property but many then went on merely to define the property and did not explain the link between the property and the feature of the thermometer as required by the questions.

(b) (i)(ii) Most candidates gained some credit. In **(i)**, despite the question clearly stating a choice between water or alcohol, a number of candidates wrote *mercury*. In **(ii)**, a lack of detail often resulted in full credit not being gained, e.g. by simply stating that alcohol has a low freezing point, rather than stating that the freezing point of alcohol was below -10 °C.

Question 7

(a) Most candidates gained full credit.

(b) (i)(ii) Most candidates recognised that the wave would be reflected, but often gave insufficient detail in their explanation to score full credit.

(iii) This was generally correctly answered but a significant number of candidates did not realise that the wavelength would not change after reflection.

(iv) This was well answered by the higher achieving candidates but many answers either did not give the correct equation or transposed a correct equation incorrectly. There were often mistakes in the conversion of 7.0 cm to metres; a final answer of 0.43 Hz was often seen.

Question 8

(a) Many responses gained full credit on this part although some candidates did not understand that the current is the same everywhere in a series circuit so $2I$ was often seen in the box for current.

(b) (i)(ii) These were generally well answered, most errors being incorrect substitution due to not understanding what the quantities really meant.

(iii) Only the highest achieving candidates correctly determined the power supply to the factory. Many candidates simply calculated without explanation 8.4×10^5 W, the power loss in the cables, a valid step towards calculating the power supply, possibly thinking that this was the final answer.

Question 9

(a) A significant number of candidates wrote about step-up or step-down transformers without explaining how a transformer works, or attempted an explanation with a vague account using some of the terms involved in the operation of a transformer. Those lower achieving candidates who did attempt an explanation, often did not indicate clearly that there is a changing flux in the transformer or stated that the changing flux induced a current rather than an e.m.f. in the secondary coil. A significant number of candidates did not discuss at all the situation with a d.c. supply; presumably they had not read the question carefully.

(b) (i) Many candidates attempted unsuccessfully to use the turns ratio to calculate current in the secondary coil. Only the higher achieving candidates were able to equate power input and power output.

(ii) Only a minority of candidates stated that the transformer should be 100% efficient or have no losses.

Question 10

(a) (i) Most candidates identified the electron but struggled with the rest of the question. Many wrote about the decay of alpha and beta particles. Most statements about half life were very vague and inappropriate, giving the impression that half life was a process that the radioactive source undergoes rather than a time and explaining its significance in this case.

(ii) A significant number of candidates did not state that the range of alpha particles in air is less than 10 cm or link this to a correct property of the alpha particle. Many candidates did gain credit for statements that included the idea that alpha particles are strongly ionising. Many others stated that the alpha particle itself was ionised.

(b) Most candidates had the right general idea but lost credit through careless drawing, e.g. starting the deflection of the electron halfway along the plates.

Question 11

(a) Excellent accurate diagrams were drawn by a minority of candidates but overall the standard of drawing of the ray diagram was variable. The instruction in the question, “carefully complete”, meant candidates were expected to draw the normal at Q reasonably accurately, measure angles of incidence and reflection and use a ruler to draw the path of the ray. An accurately drawn ray left the optical fibre without further reflection after Q. Many candidates sketched the typical zig-zag pattern of a ray in an optical fibre without consideration of this particular case, often with large differences between angles of incidence and reflection and rays that were not straight lines. Sometimes refracted rays were shown, or the ray stopped or changed direction in the middle of the fibre.

(b) Many candidates were able to correctly determine the critical angle and most gained some credit for the use of Snell’s Law.

(c) Most candidates correctly stated *total internal reflection* but often did not state the necessary condition, that the angle of incidence was greater than the critical angle.

PHYSICS

Paper 0625/33

Extended Theory

Key Messages

Candidates can only do well on this paper if they are familiar with the entire syllabus, both Core and Supplement. It was clear that most candidates had indeed studied the syllabus and many candidates scored well on challenging questions. A few candidates showed familiarity with some topics whilst being significantly less familiar with others.

In numerical questions, candidates should show their working and not just write down the answer, even when the intermediate stages were performed using a calculator. It was particularly pleasing to note that most of the candidates for this session were meticulous about the use of units and gave an appropriate number of significant figures. Whilst candidates are not generally penalised on this paper for the use of too many significant figures, it is good practice to give answers to the number of significant figures in the question (or one more). In multi-stage calculations, however, candidates should be careful not to introduce rounding errors by rounding their answers too early.

Some candidates find rearranging equations challenging and errors are frequently made when numbers are substituted into formulae such as $½mv^2$, with the square often being omitted.

General Comments

In general it is the direct, factual recall questions where most candidates produce the expected answer.

A small number of candidates write their answers in pencil before tracing over the pencil with pen; this should be discouraged as it usually produces an answer that is very difficult to read even if the pencil is then erased.

When a candidate wishes to change or replace an answer that already fills the answer space, it is helpful to the Examiners if they write the additional or replacement answer clearly elsewhere and then make reference to its location in the original answer space. Answers must not, however, be written on the front page.

Examiners make every effort to read answers that are poorly written, but when an answer is undecipherable then there is little that can be done to credit the candidate for it.

Comments on Specific Questions

Section A

Question 1

(a) (i) This proved challenging for a significant number of candidates; whilst many candidates were credited for supplying the correct answer, slightly more did not realise that the answer was related to the behaviour of the parachutist and tried to obtain an answer from the graph, which had no scale.

(ii) A few candidates who had not obtained the correct answer in **(a)(i)** gave a correct explanation here. The phrase *it is equal to gravity* was not considered sufficiently precise for credit to be awarded. The *force* (in SI units) of gravity acting on the parachutist is very much larger than 10.

(b) This part was better answered with many candidates knowing exactly what was expected. Some candidates tried to describe what was happening in rather more colloquial terms rather than being exact and referring to the gradient of the graph.

(c) This was very well answered and most candidates gave the expected answers. Some candidates lost credit for merely making one of the two points expected. An explanation was required here.

(d) There were many good answers here but the most common error was to draw a graph which suggested that the parachutist would have the same final speed as before. Candidates were asked to sketch their graph on Fig.1.1; when a separate graph was drawn in the empty space below the question it was not possible to compare it with the graph already given, so candidates did not gain full credit in this case.

Question 2

(a) (i) This straightforward calculation was often correct. Candidates should be congratulated because the overwhelming majority of answers had both the correct numerical value and the correct unit.

(ii) This calculation was also performed well by many candidates and the answer given was frequently correct. There were errors, however, and some candidates were uncertain as to what the force was divided by. Both the volume and the length 0.30 m appeared in the answers here, even when the formula $P = F/A$ had just been referred to.

(b) (i) A number of candidates drew horizontal arrows, although most candidates did answer this part correctly.

(ii) This part certainly produced a variety of answers with some candidates giving two correct answers after a little working out. A common cause of lost credit was the use of a diagonal distance rather than the perpendicular distance. This usually involved the use of the Pythagoras Theorem and led, of course, the wrong answer. This was sometimes done even when the word perpendicular had been written down by the candidate when referring to the formula.

(iii) Many candidates gave the expected answer here. A few thought that, despite the wording of the question, the slab would slide across the ground.

Question 3

(a) This calculation was very commonly performed correctly, although some candidates omitted the g in both the calculation and the formula quoted.

(b) (i) Many candidates referred to the temperature difference, or the original or final temperature of the metal spheres. This was often well answered.

(ii) This was less well with few answers mentioning the loss of thermal energy to a specific destination. Some candidates produced answers of the form *heat and sound* without explanation or applying it specifically to the case that the question required.

(iii) Many candidates referred to taking an average value or implied that this might lead to reducing the effect of anomalous results. Only some candidates made both marking points.

Question 4

(a) There were many candidates who knew what was expected and who then obtained the correct answer. A significant number, however, were uncertain as to how the question should be answered and either tried to use $P = F/A$ or just used the numbers in the question apparently randomly to find a value of some sort.

(b) (i) The word *random* featured extremely commonly here and this almost invariably obtained credit. A minority of candidates, however, described the motion of the air molecules and ignored the smoke particles. This is not what the question was asking for.

(ii) Many candidates gave an appropriate explanation in terms of the collisions but a not infrequent misunderstanding was to refer to collision between the smoke particles, or to collisions between the smoke particles and the walls of the container.

(c) This was very well answered. A few candidates spent quite a lot of time drawing large arrays of molecules and this led, in some cases, to deteriorating quality as the final molecules were put in place. The best answers included fewer than twenty molecules.

Question 5

(a) Many candidates approached the question in two stages, and gained full credit. Some candidates used a formula that combined both stages and were well rewarded for the calculation that resulted. This was a question where answering the question on the calculator, without including any working on the answer paper, caused a few candidates to incur a substantial penalty for what might well have been just pressing the wrong key.

(b) This was usually well answered with most candidates making one or two of the salient points. There were candidates who stated that there was an electric current in the fibre optic cable.

Question 6

(a) There were many good answers, with the majority of candidates stating in some way or other that the conduction property of a material depends on the presence or absence of free electrons. Some simply referred to charges; this answer was not considered sufficiently precise. Other candidates referred erroneously to mobile ions in metals. The marking point relating to the motion or flow of the electrons was not gained by candidates who stated vaguely that the electrons *pass on the electricity* since this says little more than had already been stated in the question.

(b) (i) This was often correct although some good answers were spoiled by the addition of other types of energy.

(ii) Most candidates realised what was needed and used the formula *VIt* in some way. There were candidates who simply substituted 10 (minutes) and did not obtain full credit.

(iii) This was less well answered, with a significant number of candidates calculating 0.88 (88%) of their answer to **(b)(ii)**. The change from energy to power had been overlooked.

Question 7

(a) Most candidates underlined the correct value, with the remaining candidates underlining one of the others in almost equal numbers.

(b) Many candidates had some idea that there was some quantity or property that was closer or more densely packed in a compression than in a rarefaction but rather fewer gave an appropriate property. Common answers that did not obtain full credit referred to the waves being closer together or even the wavelength or the frequency being different at the two features. A few of the lower achieving candidates gave a form of the dictionary definition of *compression* and then went on to define *refraction*. The best answers avoided using the word *compressed* when describing a compression.

(c) (i) Many obtained full credit either for the correct answer or for a correctly deduced answer that used their wrong value from **(a)**. A small minority omitted the factor of two altogether or divided by it rather than multiplying.

(ii) This was well answered by a large number of candidates.

Question 8

(a) This was almost invariably correct.

(b) (i) This piece of direct, factual recall was very commonly incorrect, with answers ranging from *amperes* and *volts* to *joules* and *watts*. Oddly, this included many candidates who correctly used the unit *coulomb* or more commonly the symbol C in **(b)(ii)**.

(ii) This part was often well answered with many candidates giving the correct value with the correct unit. The correct equation $I = Q/t$ was rearranged to give $Q = I/t$ by a fair number of candidates, so producing a wrong value.

(iii) This calculation was very well performed and most candidates obtained full credit.

(c) This quite tricky calculation was well performed and candidates were clearly familiar with what was needed.

Question 9

(a) (i) This was quite commonly well answered and many candidates gained credit.

(ii) This was quite commonly well answered and many candidates gained credit.

(b) (i) Although many candidates made one or perhaps even two relevant points here, it was only a minority of candidates who realised that this was a question concerning electromagnetic induction and who obtained full credit.

(ii) This part followed on from the previous part and so again it was only a minority which produced completely correct answers here.

Question 10

(a) Although many candidates did obtain full credit, rather more gave answers which were too general.

(b) (i) This was rather poorly answered in general with most candidates listing the properties of γ-rays rather than answering the question that was asked.

(ii) This part was approached rather more successfully. The majority of candidates stated that the count rate would decrease and of these many made specific statements that it would not fall to zero.

(c) (i) The correct box was almost always ticked.

(ii) Many candidates produced a correct explanation. The answer *magnetic fields do not affect γ-rays* was not sufficiently precise to obtain any credit here.

PHYSICS

Paper 0625/04
Coursework

General Comments

The moderated samples of coursework showed that the candidates had been given many opportunities to fully demonstrate their practical skills using a range of tasks from different areas of the specification. Clearly a large amount of good work had been completed by teachers and candidates. The samples illustrated clear, annotated marks and comments, which was helpful during the moderation process.

The general standard of coursework continues to reach a high level.

Skill C1 Using and Organising Techniques, Apparatus and Materials.

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

Skill C2 Observing, Measuring and Recording.

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

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

Skill C3 Handling Experimental Observations and Data.

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

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

Skill C4 Planning and Evaluating Investigations.

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

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

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

PHYSICS

Paper 0625/51
Practical Test

Key Messages

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

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

General Comments

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

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

The majority of candidates entering this paper were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of every practical test were attempted and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly, record observations clearly and perform calculations accurately and correctly. Units were well known and usually 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 questions differentiated well between candidates of differing abilities, for example in **Question 2** only the highest achieving candidates were able to fully justify their statement. In **Question 3** few candidates supplied an answer within the context of the question.

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, causes difficulty for many candidates. Some candidates have difficulty 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 majority of candidates carefully recorded sensible readings for the height and top and bottom diameters of the cup, in the correct order. The calculations were usually carried out correctly although some candidates did not square the average diameter or forgot to divide by 4.

(b) (i) Candidates were instructed to show their working; candidates who did not do so could not be awarded credit for measuring at least two values of circumference, using the string provided. Correct arithmetic for the circumference *C* leading to a value within the tolerance gained the second marking point. The third marking point was awarded for giving this final answer to 2 or 3 significant figures, appropriate for these measurements made using string and a metre rule, since the length of string could not be determined more precisely than to the nearest millimetre.

(ii) Many candidates drew clear diagrams showing appropriate experimental technique, either indicating clearly that the string was wrapped around the cup half-way up, or similarly used at the top and the bottom of the cup.

(c) (i) Most candidates recorded a value of volume that was within the tolerance allowed.

(ii) This part enabled candidates to show an understanding of the practical skills involved in making measurements and the uncertainties related to measuring instruments. The question could be answered in a number of ways and credit was given for a variety of sensible and thoughtful responses. For example, some candidates explained that more uncertainties are introduced when a series of measurements is required to obtain the result.

Question 2

(a) The majority of candidates recorded a realistic value for room temperature. A minority appeared to record the initial temperature of the hot water.

(b) – (d) Candidates were expected to record the times, in seconds, in the first column of the table. Most candidates made careful measurements with the temperatures recorded showing a decrease in both temperature columns, with a larger decrease in temperature during the first time interval than the final time interval. Most candidates followed the instruction to complete the column headings and the majority of these candidates correctly entered the appropriate units.

(e) Candidates were required to make a statement that matched their readings and with some reference to the readings to gain credit for the first marking point. The second marking point was awarded to those candidates who went on to write a clear justification. Examiners judged the candidates' answers in relation to the readings presented, rather than any expected results.

(f) Many candidates correctly suggested the use of a lid.

(g) Candidates were asked for one suggestion, and should write only one although there are several sensible suggestions that could be made. No credit can be awarded where a candidate gives several suggestions, one of which is incorrect. Confident candidates were able to suggest room temperature, initial water temperature or volume of water.

Question 3

(a) Most candidates were able to record sensible values for the potential difference, to at least 1 decimal place, and current, to at least 2 decimal places, reflecting the precision to which their meters could be read. Some candidates appeared to have read their meters wrongly, giving values that were out by powers of 10. In spite of having the circuit set up for them, some candidates recorded currents that were not approximately the same.

(b) Most candidates were able to label the graph axes correctly and choose a scale that made good use of the grid. Some candidates did not follow the instruction to start both axes at the origin (0,0). Plotting was generally accurate, but a significant number of candidates lost some credit for drawing a dot-to-dot line rather than a best-fit line.

(c) Candidates were expected to answer this part in relation to their graph. Some candidates appeared to ignore the evidence from their experiment and give an answer that contradicted that evidence. Most candidates had results that gave a straight line trend and many gave this as the reason for their statement that resistance is proportional to length, neglecting to include the necessary comment about the line passing through (or close to, allowing for experimental inaccuracies) the origin. The instruction to start both axes at the origin was included in order to help candidates with their conclusion.

(d) In spite of having a 1 metre resistance wire in front of them, few candidates realised that they should have suggested using further values of length beyond 50 cm.

Question 4

(a) In parts **(i)** and **(ii)** and **(iv)**, some candidates gave answers that were outside the tolerance allowed, suggesting that they had not found an image. In part **(iii)**, most candidates correctly drew an inverted image.

(b) Most calculations were correct but some candidates wrongly included a unit for one or both of the ratios.

(c) Here candidates were asked to think carefully about their experiment and make a judgement on the results. The Examiners awarded marks in relation to the candidates' own results. Successful candidates were able to make a clear statement and justify it by commenting on the closeness (or otherwise) of the two values.

(d) Successful candidates made relevant suggestions from their experience. Others made vague suggestions that only amounted to writing that they would follow the instructions carefully. This did not gain the available credit. The question asked for two precautions. There are more than two possible correct answers but candidates should be warned against offering more than the number requested as they run the risk of effectively asking the Examiner to choose the correct answers from a list – it is the candidates' task to select two precautions and credit is awarded accordingly. Some candidates appeared to be relying on answers they had learned from past papers which often resulted in irrelevant responses such as 'place the pins far apart'.

PHYSICS

Paper 0625/52
Practical Test

Key Messages

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

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The majority of candidates entering this paper were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of every practical test were attempted and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly, record observations clearly and perform calculations accurately and correctly. Units were well known and usually 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 questions differentiated well between candidates of differing abilities, for example in **Question 2** only the highest achieving candidates were able to suggest one possible disadvantage of using the method described in **(c)** to produce a steady flow of water for use in the experiment they had carried out in **(b)**. The conditions needing to be kept constant between repeated experiments posed problems for some candidates, with only the highest achieving candidates listing two clear and unambiguous conditions. The gathering and recording of data presented few problems for any candidates. There was evidence of some candidates not having the use of a calculator.

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

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

Comments on Specific Questions

Question 1

(a) Most candidates recorded sensible values for the height, width and depth of the piece of modelling clay. A penalty was incurred if the values recorded were not all written to the nearest millimetre. The volume V_A of the sample of clay was usually calculated correctly.

The mass of the clay was almost invariably recorded, and a value for the density of the modelling clay calculated. Most candidates arrived at an answer that was sensible and within the tolerance allowed.

(b) (i) The majority of candidates, having moulded their cube of modelling clay into an approximate spherical shape and measured its diameter, wrote down values that were sensible and larger than the height, width and depth of the original cube.

(ii) Candidates were instructed to use the blocks of wood and the rule provided to help them measure the diameter of the sphere. The candidates' diagrams showing how they used the blocks and the rule were very often carelessly drawn. To obtain credit here, the Examiner expected to see the blocks positioned either side of the sphere, and touching it, with the ruler spanning the gap between the blocks and touching them. A sizeable minority of candidates who had produced acceptable values for the diameter of the sphere, drew diagrams which indicated that they had no idea of how to use the blocks and the ruler.

(c) Most candidates poured the correct volume V_1 of water into the measuring cylinder. Very few candidates wrote down a volume that was not between 90 and 110 cm^3.

The volume V_2 was universally recorded as being larger than V_1, and the volume V_B of the modelling clay calculated correctly.

(d) Most candidates realised that the volume of the modelling clay should not change when the shape was changed, but found difficulty in giving two reasons as to why their values of V_A and V_B were different. Despite the instruction that the experiment had been carried out <u>with care</u>, candidates often attributed this difference as being due to poor experimental practice, such as water spillages, splashes or not reading the level of water in the measuring cylinder to the bottom of the meniscus. Common correct answers were that the cube was not perfectly shaped and therefore difficult to measure accurately, that the volume of the string might add to the volume when the clay was immersed in the measuring cylinder or that some clay might be left on the fingers whilst moulding it.

Question 2

(a) The temperature of the cold water was almost always recorded, with candidates giving a value within the allowed limits. Very occasionally, candidates ignored the given instruction and quoted a value which was obviously the temperature of the hot water supplied.

(b) Almost all candidates were able to follow the instructions given and produced a completed table showing how the temperature of the hot water changed as the volumes of colder water were added. Where an error occurred, it was usually that the candidate had not recorded the cumulative volumes of cold water added, but merely listed the incremental steps of 10 cm^3 each time.

(c) Most candidates followed the instructions and measured and recorded the times t_1 and t_2 for two consecutive volumes of 50 cm^3 of water to fall through the hole in the bottom of the cup into the measuring cylinder. Both rates of flow were generally calculated correctly, but credit was often lost due to incorrect rounding of the calculator values. Units were usually supplied with the calculated rates, a common error being the use of cm / s instead of cm^3 / s.

(d) This part was more challenging, and only the higher achieving candidates realised that the rate of flow of the water would not be constant. It was pleasing to see that some candidates were able to state that the rate of flow would decrease and went on to explain this in terms of the reducing pressure on the base of the cup.

(e) Most candidates were able to give at least one valid condition that needed to be kept constant if the experiment were to be repeated to check the results. Candidates should be advised that in experiments of this type, it is important to specify whether they are referring to the cold or the hot water.

Question 3

(a) All candidates produced completed tables. Some candidates omitted to complete the heading for each column of the table, or missed out the unit for length.

(b) Graph plotting was generally of a good standard. Most candidates chose horizontal and vertical scales which made use of at least half of the given grid. Few candidates made use of scales which increased in inconvenient increments, such as 3 or 7; choosing such scales makes the points much harder to plot and more difficult for the Examiners to check the candidates' plotted points.

There were a significant number of graphs where the points were joined dot-to-dot. When best-fit lines were attempted, they were often biased to one side, or even forced through the origin. The concept of a best-fit line is clearly not well understood by all.

(c) Most candidates were able to make an attempt to determine the gradient of the graph they had drawn. Often some credit was lost because the candidate ignored the given instruction to indicate clearly on the graph the 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) Many methods, some ingenious, were adopted by candidates to predict the resistance of 1.00 m of the resistance wire and most candidates arrived at a sensible answer. However, the values quoted by some candidates were obviously incorrect, and far from the values shown by their tables and graphs. Candidates should spend a moment looking at the value of any prediction they make, and ask themselves if this value is realistic.

Question 4

(a) – (j) It is pleasing to report that the standard of drawing, in terms of both the accuracy and neatness of both ray traces, was excellent. Almost invariably the normals were drawn correctly in the right position, the angles of incidence were correct to within 1° and all the required lines were present and neatly drawn. The required angles of refraction were measured and recorded and were generally correct to 1° and were within 2° of each other. Occasionally, the angle of refraction was measured from the ray to the glass block, and not to the normal.

(k) Most candidates were able to state whether or not their results supported the statement given. Far fewer 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.

(l) Most candidates were able to give one valid precaution for obtaining reliable results when performing optics experiments, and many candidates gave two valid precautions. One common incorrect answer, supplied by many candidates, was to carry out the experiment in a dark room; when pins are used instead of ray boxes, good lighting is an essential.

PHYSICS

Paper 0625/53

Practical Test

Key Messages

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

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

All questions differentiated well between candidates of differing abilities, for example in **Questions 3** and **4** only the highest achieving candidates were able to produce clear explanations and justify conclusions adequately.

The gathering and recording of data presented few problems for any candidates.

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, causes difficulty for many candidates. There were also many examples of instances where a candidate had repeated a measurement and had overwritten their first answer. This often made it difficult for the Examiner to see what the reading was, and sometimes the Examiner was unable to award credit. Candidates should cross out completely and re-write their answers so that there is no ambiguity. Some candidates have difficulty choosing an appropriate scale to plot their graphs and in drawing a best-fit line to display their data.

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

Comments on Specific Questions

Question 1

(a) Most candidates made an accurate measurement of the object, reflecting the dimensions that had been given in the Confidential Instructions to Centres. It is expected that measurements with a ruler should be recorded to at least the nearest mm.

(b) h_I measurements were generally recorded correctly, although a minority of candidates gave increasing or unchanging values, presumably through lack of care with the procedures.

(c) *S* values were usually calculated correctly. A small number of candidates calculated the inverse ratio.

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

Plotting was generally of a high standard with many candidates correctly using small crosses instead of dots, which are sometimes obliterated by the line. Only a minority lost credit due to dots that were too large to be accurate plots.

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

Many found the judgement of the line of best fit challenging, but only a very small number joined points together or produced thick lines. It is expected that all points will be taken into account when drawing a best-fit line, even if a curve is suggested, although if, through incorrect plotting, a point is clearly inconsistent with the general trend, it should be marked as an anomaly and ignored.

(e) There was quite a variation in how candidates showed their method of finding the gradient. A triangle was clearest and was the most common. Use of marks on the axes or line is acceptable in some cases but is not often easy to interpret and should be avoided. A line to each axis from a single point is only a valid indication if the graph line passes through the origin, which it did not in most cases.

Many candidates had used over half the line for the determination of the gradient and the value of the focal length was often in the accepted range of 14 cm to 16 cm.

Question 2

(a)(b) Most candidates recorded temperature readings clearly, with the majority giving correct °C units. A few omitted the 0 s value in the *t* column while a very small number left the units blank. Both sets of θ values were generally decreasing steadily, although a small number of candidates recorded room temperature in the first row of the table rather than the initial temperature of the hot water. In most cases, the first interval in each set of temperature values was greater than or equal to the last.

(c) A large number of candidates recognised that the water cooled more quickly in test-tube **A**, giving the comparative change in temperature over 180 s as evidence. Fewer candidates pointed out that the changes took place in the same period of time, and gained the full credit. No credit was given for reference to a lower final temperature in test-tube **A** except where it was recognised that initial temperatures were equal.

(d) This question required reference to inherent difficulties in the practical procedure described. Many candidates recognised that the water levels may not be the same after replacement of the thermometer and that the temperatures might not be taken at right angles to the reading on the scale. Mention of the different initial temperatures was also accepted.

(e) Factors relating to the apparatus were asked for in this question and a number of candidates lost credit by focusing on conditions such as room temperature or the initial temperature of the water. Many correct responses referred to the size of the test-tubes, the depth of the thermometers and the thickness or area of the surface materials being tested.

Question 3

(a)(b)(c) The majority of candidates recorded V and I to at least 1 and 2 decimal places respectively, reflecting the precision of their meters. Decreasing values in most cases showed that the circuits had been connected correctly.

In some cases, candidates clearly had problems with setting up the circuits and Centres had indicated that help had been given. While some credit is, necessarily, deducted for this, candidates do gain significantly through being able to carry out the remaining procedures.

Resistance was often calculated correctly and the appropriate column headings were entered by many candidates. While very few used more than the accepted 2 or 3 significant figures to record resistance, a small number showed a 'recurring' symbol. As this indicates an indeterminate number of significant figures, credit was not given. Use of this symbol should be avoided.

(d) A minority of candidates indicated correctly that the difference in resistance values was too far outside acceptable limits of experimental accuracy for them to be considered the same. Most stated simply that the resistances were different.

(e) This question required a link to be made between brightness of a lamp and the temperature of its filament. Better responses then compared the higher resistance of the brightest lamp (in circuit 1) to the lower resistances of the dimmer ones.

Some candidates stated that, as no record of temperature had been made, the comparison could not be carried out. It should be noted that questions will not be asked where there is insufficient data to make an adequate response. Candidates should have observed the difference in brightness of the lamp in different circuit arrangements.

(f) A number of candidates gave the correct symbol for a variable resistor. Some, however, showed a thermistor symbol, a plain diagonal line or simply a resistor without the expected diagonal arrow.

Some credit was given for a correct series circuit, even where the variable resistor symbol was incorrect.

Question 4

(a) Most candidates were able to provide a sensible measurement of less than 100 cm.

(b) Many were able to address the practical issues involved in making sure that the mass was correctly placed at the 60 cm mark.

The best answers indicated that the edges of the mass should be at 60 cm ± half the width of the mass, or that a line on the centre of the mass could be matched up with a mark on the side of the rule. Credit was given to responses referring to lining up the slot in a mass with the 60 cm graduation on the rule.

Good sets of decreasing h values, recorded to at least 1 decimal place, were seen in many responses.

(c) Most candidates made the correct calculations although some multiplied values from the wrong columns.

(d) Very few candidates recognised that ($d \times H$) should be constant for inverse proportionality. Credit was given to those who used the constant of proportionality from one set of values to show that another value of d would not produce the H value in the table with the same constant. Some candidates correctly showed that d decreasing from 60 cm to 30 cm was not reflected by a doubling of H.

Common incorrect answers stated that 1/*d* was not equal to *H* or that a trend of increasing ($d \times H$) was not followed by all sets of values. Candidates also mistakenly compared differences in corresponding pairs of *d* and *H* values rather than their ratios.

(e) Many candidates correctly referred to the rule's own mass or weight as a cause for the deflection without an additional load being applied.

A number of, mainly higher achieving, candidates gained some credit for showing a method of measuring this deflection. The most straightforward answers referred to measuring the height of the rule at the clamped end and subtracting the measurement of the height at the free end. Where candidates mentioned measurement of the free end of a horizontal rule, an indication of how it could be shown to be horizontal was required. Diagrams successfully supported many of the correct responses.

PHYSICS

Paper 0625/61
Alternative to Practical

Key Messages

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

General Comments

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- 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. No parts of any question proved to be inaccessible to candidates and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly, record measurements clearly and perform calculations accurately and correctly. Units were well known and were often included, writing was legible and ideas were expressed logically. However, many candidates seemed less able to derive conclusions from given experimental data and justify them.

All questions differentiated well between candidates of differing abilities, for example, **Questions 1(e)**, **2(c)**, **3(d)** and **5(b)**, where the conclusions and the justifications in support of them, or the suggestions made, allowed the better candidates to demonstrate their ability.

Comments on Specific Questions

Question 1

(a) – (d) Most candidates drew neat and accurate normals and rays. However, a significant number of candidates were unable to correctly position the ray box.

(e) Successful candidates made relevant suggestions from their experience. Others made vague suggestions that only amounted to writing that they would follow the instructions carefully. This did not gain the available credit. The question asked for two precautions. There are more than two possible correct answers but candidates should be warned against offering more than the number requested as they run the risk of effectively asking the Examiner to choose the correct answers from a list – it is the candidates' task to select two precautions and marks are awarded accordingly. Some candidates appeared to be relying on answers they had learned from past papers which often resulted in irrelevant responses such as 'place the pins far apart'.

Question 2

(a) Most candidates correctly recorded the temperature.

(b) Most candidates correctly completed the column headings although some wrote the quantity rather than the unit and others left this part blank.

(c) The majority of candidates realised that the readings showed that the insulation has no significant effect and gained credit for the first marking point by stating this and making some relevant reference to the readings. Fewer candidates gained full credit by also clearly stating that the differences in readings between the two columns were too small to be significant.

(d) Many candidates correctly suggested the use of a lid.

(e) Candidates were asked for one suggestion here and should write only one although there are several sensible suggestions that could be made. No credit can be awarded where a candidate gives several suggestions, one of which is incorrect. Confident candidates were able to suggest room temperature, initial water temperature or volume of water.

Question 3

(a) Many candidates recorded the resistance values correctly although a significant number made rounding errors. Often the values were not expressed to a consistent level of precision.

(b) Most candidates were able to label the graph axes correctly and choose a scale that made good use of the grid. Some candidates did not follow the instruction to start both axes at the origin (0,0). Plotting was generally accurate, but a significant number of candidates lost some credit for drawing a dot-to-dot line rather than a best-fit line.

(c) Candidates were expected to answer this part in relation to their graph. Some candidates appeared to ignore the evidence and gave an answer that contradicted that evidence. Most candidates had correct resistance values that gave a straight line trend and many gave this as the reason for their statement that resistance is proportional to length, neglecting to include the necessary comment about the line passing through (or close to, allowing for experimental inaccuracies) the origin. The instruction to start both axes at the origin was included in order to help candidates with their conclusion.

(d) In spite of the question stating that a 1.00 m resistance wire is used, few candidates realised that they should have suggested using further values of length beyond 50 cm.

Question 4

(a) Most candidates correctly recorded the values of *u* and *v*.

(b) The majority of candidates calculated the ratio correctly but some wrongly included a unit.

(c) Most candidates correctly gave answers that were 10 times the answers in **(a)** but some gave responses that were 10 times smaller than *u* and *v*. Others gave answers that appeared to have no relation to *u* and *v*.

(d) The majority of candidates measured *x* accurately. Some lost credit by omitting the unit.

(e) Here candidates were asked to think carefully and make a judgement on the results. The Examiners awarded marks in relation to the candidates' own values. Successful candidates were able to make a clear statement and justify it by commenting on the closeness (or otherwise) of the two values.

(f) Successful candidates made relevant suggestions from their experience. Others made vague suggestions that only amounted to writing that they would follow the instructions carefully. This did not gain the available credit. The question asked for two precautions. There are more than two possible correct answers but candidates should be warned against offering more than the number requested as they run the risk of effectively asking the Examiner to choose the correct answers from a list – it is the candidates' task to select two precautions and marks are awarded accordingly. Some candidates appeared to be relying on answers they had learned from past papers which often resulted in irrelevant responses such as 'place the pins far apart'.

(g) A range of responses was seen here. Often these were vague or irrelevant. Candidates who were able to write from their experience knew that the image would be inverted.

(h) The most confident candidates were able to explain clearly how to take the measurements at the middle of the range where the image is sharp.

Question 5

(a) The majority of candidates recorded accurate readings for the height and top and bottom diameters of the cup, in the correct order. The calculations were usually carried out correctly although some candidates did not square the average diameter or forgot to divide by 4. In spite of the question asking for an approximate value for the volume, many candidates gave answers to more than 3 significant figures, which was not appropriate for a quantity derived from measurements made only with a ruler to the nearest millimetre. Some omitted the unit.

(b) Many candidates correctly suggested measuring the circumference half-way up the cup, or at the top and bottom and taking the average. Others suggested using more than one revolution of the string, measuring the length and dividing by the number of revolutions. Few candidates, however, included both techniques in order to gain full credit.

(c) A significant number of candidates took the reading at the top of the meniscus ($230\,cm^3$) and so did not gain credit for the first marking point. Most, however, correctly subtracted their value from $500\,cm^3$ and so gained some credit.

(d) Most candidates showed clearly on the diagram that the line of sight required is perpendicular to the scale.

PHYSICS

Paper 0625/62
Alternative to Practical

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

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- 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. Most candidates demonstrated that they were able to draw upon their own personal practical experience to answer the questions. No parts of any question proved to be inaccessible to candidates and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly, record measurements clearly and perform calculations accurately and correctly. Units were well known and were invariably included, writing was legible and ideas were expressed logically. However, many candidates seemed less able to derive conclusions from given experimental data and justify them.

The questions differentiated well between candidates of differing abilities, for example **Questions 1(e)**, **2(e)**, **4(d)** and **5(b)(ii)**, 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 all questions on the paper and there were very few scripts with a substantial number of blank responses. 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 measured the height, width and depth correctly to the nearest millimetre, but a minority of candidates were up to 2 mm out.

The volume V_A of the cube of modelling clay was usually calculated correctly, but some candidates lost credit due to rounding errors in their answers.

The calculation of the density of the clay presented few problems, but many candidates lost credit because they quoted their answers to too many significant figures or omitted the unit for density in their answers.

(b) Answers to this part were often spoiled by careless drawing of the experimental set-up. What was expected was that the candidates' diagrams would show the sphere between and touching the two wooden blocks, with the ruler spanning the gap and touching the blocks. A minority of candidates did not know how to use these basic pieces of apparatus to determine the diameter of the clay sphere.

(c) The volume of water in the measuring cylinder was correctly read from its scale by the majority of candidates. Where errors occurred, the most common incorrect answers were 63 cm^3 and 72 cm^3. Most candidates gained the credit for a correct line of sight.

(d) The volume V_B of the modelling clay was almost universally calculated correctly by subtraction. Candidates who had read the scale of the measuring cylinder incorrectly in the previous part were given full credit for a correct subtraction of volumes.

(e) Most candidates realised that the volume of the modelling clay should not change when the shape was changed, but found difficulty in giving two reasons as to why their values of V_A and V_B were different. Despite the instruction that the experiment had been carried out <u>with care</u>, candidates often attributed this difference as being due to poor experimental practice, such as water spillages, splashes or not reading the level of water in the measuring cylinder to the bottom of the meniscus. Common correct answers were that the cube was not perfectly shaped and therefore difficult to measure accurately, that the volume of the string might add to the volume when the clay was immersed in the measuring cylinder or that some clay might be left on the fingers whilst moulding it.

Question 2

(a) Most candidates read the thermometer correctly. Where the thermometer was misread, the most common incorrect answer was 21 °C. Only a small minority of candidates did not include a unit or gave an incorrect unit.

(b) Almost all candidates were able to follow the instructions given and produced a completed table showing how the temperature of the hot water changed as the volumes of cold water were added. Where an error occurred, it was usually that the candidate had not recorded the cumulative volumes of cold water added, but merely listed the incremental steps of 10 cm^3 each time. Occasionally the unit V, instead of cm^3, appeared at the head of the volume column.

(c) The majority of candidates were able to list one sensible method of reducing the loss of thermal energy to the surroundings during the experiment.

(d) Most candidates followed the instructions and calculated the rates of flow correctly, but credit was often lost due to incorrect reading of the stopwatch scales or incorrect rounding of the calculator values. Units were usually supplied with the calculated rates, a common error being the use of cm / s instead of cm^3 / s.

(e) This part was more challenging, and only the higher achieving candidates realised that the rate of flow of the water would not be constant. It was pleasing to see that some candidates were able to state that the rate of flow would decrease and went on to explain this in terms of the reducing pressure on the base of the cup.

(f) Most candidates were able to give at least one valid condition that needed to be kept constant if the experiment were to be repeated to check the results. Candidates should be advised that in experiments of this type, it is important to specify whether they are referring to the cold or the hot water.

Question 3

(a) All candidates produced completed tables. Some candidates omitted to complete the heading for each column of the table, or missed out the unit for length.

(b) Graph plotting was generally of a good standard. Most candidates chose horizontal and vertical scales which made use of at least half of the given grid. Few candidates made use of scales which increased in inconvenient increments, such as 3 or 7; choosing such scales makes the points much harder to plot and more difficult for the Examiners to check the candidates' plotted points.

There were a significant number of graphs where the points were joined dot-to-dot. When best-fit lines were attempted, they were often biased to one side, or even forced through the origin. The concept of a best-fit line is clearly not well understood by all.

(c) Most candidates were able to make an attempt to determine the gradient of the graph they had drawn. Often some credit was lost because the candidate ignored the given instruction to indicate clearly on the graph the 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) Many methods, some ingenious, were adopted by candidates to predict the resistance of 1.00 m of the resistance wire and most candidates arrived at a sensible answer. However, the values quoted by some candidates were obviously incorrect, and far from the values shown by their tables and graphs. Candidates should spend a moment looking at the value of any prediction they make, and ask themselves if this value is realistic.

Question 4

(a) The majority of candidates labelled the extremities of the incident ray correctly and drew a correct refracted ray. Occasionally the angle of refraction was drawn at an angle of 70° to the normal, instead of the required 20°.

(b) Most candidates knew that the emergent ray would be parallel to the incident ray, and showed this on their diagrams.

(c) (i) Most candidates marked the positions of pins P_3 and P_4 too close together. Candidates should be reminded that to trace the path of the refracted ray accurately with pins, the pins should be as far apart as possible; credit was only given to those who drew the pins at least 5 cm apart.

(ii) Most candidates were able to give one valid precaution for obtaining reliable results when performing optics experiments, and many candidates gave two valid precautions. One common incorrect answer, supplied by many candidates, was to carry out the experiment in a dark room; when pins are used instead of ray boxes, good lighting is an essential.

A number of candidates correctly stated that the locating pins should be at least 5 cm apart, but in part **(i)** of this question they had lost credit for drawing the pins too close together.

(d) Most candidates were able to state whether or not their results supported the statement given. Far fewer 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 5

(a) The majority of candidates correctly chose the tape measure to measure the required length, but a sizeable minority of candidates thought that a 30 cm ruler or a metre rule would suffice.

(b) (i) Totally correct diagrams of the circuit required were rare. This was a standard circuit for measuring a range of currents and corresponding potential differences across a conductor, and candidates should have had experience of such circuits. Despite being told to use the standard resistor symbol to represent the sample of copper wire, many candidates drew circuit diagrams with sketches of the length of wire included in them. Although the question asked for the current to be measured for a range of potential differences, many circuit diagrams lacked the inclusion of a variable resistor/potential divider. Candidates need to read the questions thoroughly so that they understand exactly what is being asked of them.

(ii) Candidates found this part of the question challenging and most were unaware that they could check if the lamp filament is broken, or not, by simply observing the ammeter and seeing if it gives a reading. Despite the instruction being given that the lamp could not be removed from the circuit, large numbers of candidates proceeded to do just this.

(c) This more testing final part to the question was found challenging by many, and only a minority of candidates realised that a 0 – 300 V voltmeter would have far too large a range for measuring potential differences of less than 12 V because the consequent deflection would be too small.

PHYSICS

Paper 0625/63
Alternative to Practical

Key messages

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

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

General Comments

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

- handling practical apparatus and making accurate measurements
- tabulating readings
- graph plotting and interpretation
- manipulating data to obtain results
- drawing conclusions
- understanding the 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. No parts of any question proved to be inaccessible to candidates and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly, record measurements clearly and perform calculations accurately and correctly. Units were well known and were invariably included, writing was legible and ideas were expressed logically. However, candidates seemed less able to derive conclusions from given experimental data and justify them. This was most apparent in **Questions 2(c)** and **5(d)**.

All questions differentiated well between candidates of differing abilities, for example **Questions 1(e)**, **1(f)** and **5(f)** where the explanations and suggestions allowed the better candidates to demonstrate their ability.

There were very few scripts with substantial numbers of blank responses. 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 measure from the diagram correctly and convert the reading to the actual height. Very few incorrect answers contained evidence of more than a 1 mm error in the initial measurement.

(b) The best answers indicated that the edges of the mass should be at 60 cm ± half the width of the mass or that a line on the centre of the mass could be matched up with a mark on the side of the rule. Some candidates misread this question and referred to the centre of mass of the rule rather than the practical issues involved in making sure that the mass was correctly placed at the 60 cm mark.

(c) The majority of candidates entered the correct value in the table, although some did not convert to an actual height or made a similar error of measurement as in **1(a)**.

(d) Most candidates made the correct calculations, credit being given for errors carried forward from **1(a)** and **1(c)**.

(e) Very few candidates recognised that ($d \times D$) should be constant for inverse proportionality. Credit was given to those who used the constant of proportionality from one set of values to show that another value of d would not produce the D value in the table with the same constant. Some candidates correctly showed that d decreasing from 60 cm to 30 cm was not reflected by a doubling of D.

Common incorrect answers stated that $1/d$ was not equal to D or that the trend of increasing ($d \times D$) was not followed by the last set of values. Candidates also mistakenly compared differences in corresponding pairs of d and D values rather than their ratios.

(f) Many candidates referred to the rule's own mass or weight as a cause for the deflection without an additional load being applied.

A number of, mainly higher achieving, candidates gained some credit for showing a method of measuring this deflection. The most straightforward answers referred to measuring the height of the rule at the clamped end and subtracting the measurement of the height at the free end. Where candidates mentioned measurement of the free end of a horizontal rule, an indication of how it could be shown to be horizontal was required. Diagrams successfully supported many of the correct responses.

Question 2

(a)(b) Most candidates gained at least partial credit, with the majority giving correct °C units. A few omitted the 0 s value in the t column while a small number left the units blank. The θ values were generally read correctly with only a very small minority mistakenly recording the 28 °C value at the water level mark or reversing the readings.

(c) A large number of candidates recognised that the water cooled more quickly in test-tube **A**, giving the comparative change in temperature over 180 s as evidence. Fewer candidates pointed out that the changes took place in the same time period, and gained the full credit.

No mark was given for reference to the lower final temperature in test-tube **A** although answers referring to the larger gap between final temperatures compared to initial temperatures were credited.

(d) This question required reference to inherent difficulties in the practical procedure described. Many candidates recognised that the water levels may not be the same after replacement of the thermometer and that the temperatures might not be taken at right angles to the reading on the scale. Mention of the different initial temperatures was also accepted.

(e) Factors relating to the apparatus were asked for in this question and a number of candidates lost credit by focusing on conditions such as room temperature or the initial temperature of the water. Many correct responses referred to the size of the test-tubes, the depth of the thermometers and the thickness or area of the surface materials being tested.

Question 3

(a) Almost all candidates made an accurate measurement but many fewer gave this to the required 2 significant figures. It is expected that measurements with a ruler should be recorded to at least the nearest mm.

(b) The measurement was generally recorded correctly.

(c) *S* values were usually calculated correctly, credit being given for errors carried forward from parts **(a)** and **(b)**. A small minority of candidates calculated the inverse ratio.

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

Plotting was generally of a high standard with many candidates correctly using small crosses instead of dots, which are sometimes obliterated by the line. Only a minority lost credit due to dots that were too large to be accurate plots.

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

Many found the judgement of the line of best fit challenging, but only a very small number joined points together or produced thick lines. It is expected that all points will be taken into account when drawing a best-fit line, even if a curve is suggested, although if, through incorrect plotting, a point is clearly inconsistent with the general trend, it should be marked as an anomaly and ignored.

(e) There was quite a variation in how candidates showed their method of finding the gradient. A triangle was clearest and was the most common. Use of marks on the axes or line is acceptable in some cases but is not often easy to interpret and should be avoided. A line to each axis from a single point is only a valid indication if the graph line passes through the origin, which it did not in most cases.

Many candidates had used over half the line for the determination of the gradient and the value of the focal length was often in the accepted range.

Question 4

(a) The majority of candidates gave a simple response correctly identifying the pattern of increase then decrease in the value of *d*. Some made their answers over-complicated by calculating the intervals in the *d* column.

A large number of candidates gave values in the expected range. Generally, if the pattern had not been fully understood this answer was also incorrect.

(b) Many candidates gave an acceptable response here, such as the use of a sand tray. A common answer was to cover the ball in paint or ink which would leave a mark on the floor. Although not an entirely practical solution, it was credited as recognising the need for some record which could be measured later. Remote release of the ball was acceptable provided it was clear how the student could initiate the release herself while being near the landing point.

A few candidates had not read the question carefully and incorrectly suggested the use of a friend to assist.

(d) The repetition of readings was indicated by many candidates and a good number qualified the answer by suggesting calculation of an average *d* value for each angle.

Question 5

(a) The majority of candidates showed a correct symbol for a voltmeter connected in parallel with lamp **L**. Those not gaining credit either showed a series connection or gave no response.

(b) The voltmeter was read correctly by almost all candidates but a number made mistakes with the ammeter, recording 0.19 A or 1.8 A.

(c) Resistance was often calculated correctly and the appropriate column headings were entered by many candidates. While very few used more than the accepted 2 or 3 significant figures to record resistance, a significant number showed a 'recurring' symbol for the circuit 1 value. As this indicates an indeterminate number of significant figures, credit was not given. Use of this symbol should be avoided.

(d) A minority of candidates indicated correctly that the difference in resistance values was too far outside acceptable limits of experimental accuracy for them to be considered the same. Most stated simply that the resistances were different.

(e) This question required a link to be made between brightness of a lamp and the temperature of its filament. Better responses then compared the higher resistance of the brighter lamp to the lower resistance of the dimmer one.

Some candidates stated that, as no record of temperature had been made, the comparison could not be carried out. It should be noted that questions will not be asked where there is insufficient data to make an adequate response.

(f) Approximately half of the candidates gave the correct symbol for a variable resistor, others showing a thermistor symbol, a plain diagonal line or simply a resistor without the expected diagonal arrow.

Some credit was given for a correct series circuit, even where the variable resistor symbol was incorrect.