PHYSICS

Paper 0625/11
Multiple Choice

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

General comments

Candidates did particularly well on **Questions 4**, **5**, **6** and **26**, with almost all choosing the correct response. The greatest difficulty was found with **Questions 8** and **18**. **Question 38** also caused some problems, with fewer than half of the responses correct.

Comments on specific questions

Question 1

This measurement question was well answered, with distractor **C** being the most popular, these candidates failing to notice that there were *two* rotations of the can.

Question 3

The majority of candidates answered this correctly, although some failed to read that the car had travelled 60 times around the track, so opted for the physically unlikely option **A**.

Question 7

The most common misconception was that passengers standing upstairs would lower the centre of mass of the bus.

Question 8

This question concerned equilibrium, and many of the candidates opted for **B**. Although the two horizontal forces were equal, they acted at different distances from the pivot, so the handle was not in equilibrium.

Question 9

Most candidates knew which of the energy sources were renewable, the main misconception being that nuclear fuels were in this group; it should be stressed that nuclear fuel, although not a fossil fuel, is non-renewable.

Question 10

Options **C** and **D** were both quite popular distractors. Candidates needed to realise that the gravitational potential energy of the object will not be zero at Y.

Question 12

This question concerned a manometer; almost a quarter of the candidates added the 8 cm difference between the two levels to the atmospheric pressure, instead of subtracting it.

Question 15

The most common error was to select option **B**, these candidates believing that mass could be affected by temperature.

Question 18

Candidates found this the most difficult question on the paper. Option **D** was very popular, with candidates apparently confusing evaporation with convection. A significant number chose option **C**, believing that liquid molecules expand when heated.

Question 20

Although this was a very simple recall question, a large proportion of the candidates could not identify the unit of wavelength.

Question 21

Knowledge of the nature of light waves and radio waves was shown to be lacking here, with over half of the candidates choosing incorrectly. It would be worth reminding candidates that the two columns in a question do not necessarily have to have different contents for a row to be correct.

Question 22

The name of the effect shown (diffraction) was very well known, but there was considerable uncertainty about the effect of gap size on the amount of diffraction which would occur.

Question 23

This question concerned the image formed by a plane mirror. A large majority of candidates were familiar with the fact that the image is laterally inverted and not magnified, but some of these did not appreciate that it is also virtual.

Question 24

This lens question was well answered, the main misconception being that all refracted rays must pass through the principal focus.

Question 28

A significant proportion of candidates could not recognise a method by which a steel bar could be demagnetised.

Question 29

This was another simple recall question, on the unit for potential difference, and the majority of responses were correct.

Question 30

A significant number of candidates could not identify a resistor of constant resistance from its V – I characteristic.

Question 31

The circuit symbol for a fuse should have been recognised by virtually all candidates, but a significant minority gave an incorrect response.

Question 33

This question required an understanding of the potential divider. Fewer than half the candidates chose the correct response, with the rest opting for **A** and **D** in roughly equal numbers.

Question 34

Almost all candidates answered this graph analysis question correctly.

Question 35

A minority of candidates opted for **C**, being unaware that the magnetised coil could only repel another magnet.

Question 38

This question was about the change in a nucleus following emission of a β-particle. Almost half the candidates chose options **A** or **C**, showing confusion over this part of the syllabus.

PHYSICS

Paper 0625/12
Multiple Choice

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

General comments

Candidates did particularly well on **Questions 2**, **6**, **12**, **21** and **25**, with almost all choosing the correct response. The greatest difficulty was found with **Question 18**. **Question 34** also caused some problems, with about a third of the responses correct.

Comments on specific questions

Question 1

This measurement question was well answered, with distractor **C** being the most popular, these candidates failing to notice that there were *two* rotations of the can.

Question 3

The majority of candidates answered this correctly, although some failed to read that the car had travelled 60 times around the track, so opted for the physically unlikely option **A**.

Question 7

The most common misconception was that passengers standing upstairs would lower the centre of mass of the bus.

Question 8

About half of the candidates answered this correctly, but there was evidence of guessing here. Candidates need to know that only an object which is at rest or moving with constant velocity has no resultant force acting on it.

Question 9

Many candidates knew which of the energy sources were used to boil water to obtain electricity, but several thought that nuclear energy was not in this group.

Question 13

A minority of candidates believed that evaporation increased the speed of the remaining molecules.

Question 14

Most tackled this question on temperature and pressure confidently, but some thought that heating would cause the air molecules to expand.

Question 15

The most common error here was to confuse thermal capacity with latent heat, thus opting for distractor **B**.

Question 18

This question concerned thermal conduction and many candidates found it extremely difficult. The majority of candidates correctly deduced that the lowest temperature would be at end P, because of the wood's insulating properties, but most of these believed that end R of the copper would have the highest temperature. In fact, end Q of the wood will be hottest because the heat is not conducted away from the source by the wood. This can be demonstrated by using the apparatus shown in the diagram. If a piece of paper is fixed tightly around the wood/copper joint, the paper will singe on the wood side (high temperature) but not on the copper side (lower temperature).

Question 23

A significant number of candidates believed that the plane mirror in this question would form an image at point **A**, apparently unaware of the position of the virtual image formed at **D**.

Question 24

The majority of responses to this lens question were incorrect, with distractor **D** (the principal focus) being particularly popular.

Question 26

This recall question on the frequency range of human hearing was quite well answered, although a significant number chose **B**, perhaps believing that at least one of the columns must contain an audible frequency. Candidates need to appreciate that this might not be the case, as here.

Question 30

A significant number of candidates could not identify a resistor of constant resistance from its V−I characteristic.

Question 31

The purpose of a relay was known by the majority of candidates, with a fair proportion of the rest opting for each of the distractors.

Question 33

The majority chose correctly in this potential divider question, with all distractors being chosen by the rest.

Question 34

This question required candidates to choose the correct fuse for a circuit, and many of the weaker candidates opted for **C** (10 A). The normal operating current in this circuit is 10 A, and the fuse ought to be selected with a rating slightly higher than this, hence the key **D** (13 A).

Question 36

Although most candidates answered this correctly, a large proportion chose **B**, confusing slip rings with the split rings in a commutator.

Question 37

This was well answered, but some candidates were unaware that the cathode must be heated.

Question 38

Just over half of the responses were correct here, with the rest being spread between the distractors for those candidates unsure of the meaning of background radiation.

PHYSICS

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17	**D**	37	**B**
18	**A**	38	**C**
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20	**D**	40	**B**

General comments

Candidates did particularly well on **Questions 2**, **8**, **11**, **18**, **20** and **31**, with almost all choosing the correct response. The greatest difficulty was found with **Questions 5** and **12**.

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Question 1

This measurement question was well answered, with distractor **C** being the most popular, these candidates failing to notice that there were *two* rotations of the can.

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The majority of candidates answered this correctly, although some failed to read that the car had travelled 60 times around the track, so opted for the physically unlikely option **A**.

Question 5

This question concerned equilibrium, and many of the candidates opted for **B**. Although the two horizontal forces were equal, they acted at different distances from the pivot, so the handle was not in equilibrium.

Question 7

The most common misconception here was that passengers standing upstairs would lower the centre of mass of the bus.

Question 9

Options **C** and **D** were both quite popular distractors. Candidates needed to realise that the gravitational potential energy of the object will not be zero at Y.

Question 10

The most common error was to select option **B**, these candidates believing that mass could be affected by temperature.

Question 12

Candidates found this the most difficult question on the paper. Option **D** was very popular, with candidates apparently confusing evaporation with convection. A significant number chose option **C**, believing that liquid molecules expand when heated.

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Most candidates knew which of the energy sources were renewable, the main misconception being that nuclear fuels were in this group; it should be stressed that nuclear fuel, although not a fossil fuel, is non-renewable.

Question 14

This question concerned a manometer. Quite a large proportion of candidates added the 8 cm difference between the two levels to the atmospheric pressure, instead of subtracting it.

Question 21

This lens question was generally well answered, the main misconception being that all refracted rays must pass through the principal focus.

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This question concerned the image formed by a plane mirror. A large majority of candidates were familiar with the fact that the image is laterally inverted and not magnified, but some of these did not appreciate that it is also virtual.

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The name of the effect shown (diffraction) was very well known, but there was considerable uncertainty about the effect of gap size on the amount of diffraction which would occur.

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Question 35

A significant proportion of candidates could not recognise a method by which a steel bar could be demagnetised.

Question 36

A minority of candidates opted for **C**, being unaware that the magnetised coil could only repel another magnet.

Question 40

This question was about the change in a nucleus following emission of a β-particle. Almost half the candidates chose options **A** or **C**, showing confusion over this part of the syllabus.

PHYSICS

Paper 0625/21

Core Theory

Key Messages

To score well in this paper, candidates need to be able to show a sound understanding of topics throughout the syllabus and make simple calculations where needed.

General comments

Many candidates were able to show a good understanding over the whole range of topics covered by this paper which is exactly what is needed to be successful. Most candidates attempted most parts of the paper and no parts were regularly left blank. In general, candidates appeared to have been well prepared. There was no evidence that candidates ran out of time before they had completed the paper.

The mathematics involved in this paper was usually well executed, where the candidate knew the physics involved, and working was frequently well set out, although some candidates wrote down the answer without showing any working, sometimes to their cost.

In this paper, candidates are not penalised for poor writing, poor language skills or poor presentation, but credit cannot be awarded if an answer simply cannot be read unambiguously. There were some scripts that fell into this category.

Comments on specific questions

Question 1

(a) Most candidates were able to take the necessary reading and make the appropriate calculation. Some thought that distance = speed/time, and a few needlessly converted the time into minutes and/or distance into metres and usually got mixed up with units.

(b) Many candidates were confused by the idea that the car was travelling at 80 km / hour for the whole of the first ½ hour. Such candidates invariably showed a line sloping up from the origin to 80 km / hour, usually at the ½ hour mark. Thereafter, graphs were often well drawn, although many failed to show the line vertically down to the axis at the 1 hour mark.

Question 2

(a) (b) These two parts were correctly answered by almost all candidates.

(c) Most candidates knew the formula for density, although there were some who used V / M. Calculations were usually correctly done and answers given to an appropriate number of significant figures and with correct units. A fairly common mistake was to revert to one of the values of readings 3 or 4 for the mass, instead of using the mass calculated in **(b)**. The fact that the question clearly instructed candidates to state the equation they were using, meant that credit was lost if the equation was not stated, even if the numbers were correctly used to give a correct answer.

Question 3

(a) The convention, whereby force arrows start on the object where they are acting, appears to be infrequently taught, because it was rarely seen. This was, however, not penalised. Most candidates were able to score full credit, although there were some who showed one or more of the arrows in a vertical direction.

(b) Candidates were able to give the direction of the force and (usually) its size, but were far less sure about the cause of this force.

(c) Most realised that the train's speed would increase, but only the more able candidates realised anything about the forces now being unbalanced.

Question 4

(a) It was pleasing to see that many candidates had some understanding about the causes of the gas pressure in a container. Most had an appreciation that the molecules were moving and colliding with something. Many thought that the collisions were between the molecules, rather than with the wall of the container, and so did not score full credit, but answers seemed to be much better than on previous occasions when this topic has been included.

(b) Either by knowing the gas laws or by sensible thinking, a good number were able to answer both parts correctly.

Question 5

(a) All that was required here was that the energy is changed to other forms. Most answers were not as clear-cut as this statement, and Examiners often had to interpret whether the candidate was indicating that he/she did in fact mean this.

(b) The total energy needed to see and hear the programme caused few problems to the more able candidates, but suggestions about what happened to the rest of the energy suffered from the same muddled thinking as appeared in **(a)**. Most knew that a simple subtraction gave the answer to **(iii)**, but it was clear that many did not really appreciate the meaning of the term *efficiency*. Many found reasons to claim that the efficiency was high, and some answered in terms of the speed of transmitting news around the world.

Question 6

(a) (b) Often, in ray diagrams on this paper, answers are very poor. On this occasion, however, there were many excellent answers.

(c) It was often the case that contradictory boxes were ticked, and clearly this resulted in lost credit. For example, the image could not be both larger and the same size, nor could it be both upright and inverted. Candidates should be taught to ask themselves whether their answer makes sense.

(d) Answers to this part showed a lot of guesswork, and few gave both the points required. It is helpful if it can be pointed out that a smaller image must be closer to the lens and that a larger image must be further from the lens.

Question 7

By no means all candidates scored well on this question, but many scored at least half of the available credit. Nearly all, as would be expected, related injured legs to X-rays, but surprisingly the mention of "heat-seeking" did not lead all candidates towards infra-red.

Question 8

(a) By no means all candidates knew that charge/electrons flowed to cause a current. Ammeters and voltmeters were well-known, but a few answered 'ampere' in place of ammeter and/or 'voltage' in place of voltmeter.

(b) The calculation of the resistance caused few problems, although some used the formula the wrong way up. The calculation was simple and many chose not to write down their working, which is bad practice, because if a mistake is made, there is then nothing for the Examiner to reward. Units were usually given correctly.

(c) There was a lot of uncertainty about the relationship between length and resistance, and also the effect the change in length would have on the current in the wire.

Question 9

This question was generally very well done. The biggest problem faced by some candidates was in explaining exactly what they meant. Ambiguities caused by language difficulties were dealt with sympathetically.

Question 10

(a) Most had some idea of the symbol for a switch, but often it was a very approximate idea. A lot of switches showed little "terminal" circles in inappropriate places. This is one of the simplest of the circuit symbols the candidates are required to know, so it would be expected that more of them could draw it properly.

(b) Most recognised that the plug switch was the dangerous one to use with mains voltages. However, it is not the fact that it has two metal sections that makes it dangerous (all the switches have metal sections of some sort either side of the gap), but the fact that they are <u>exposed</u>, making an electric shock very likely. Few made this clear in their answers.

(c) A good number identified the ceiling-mounted switch as the most suitable, but a sizeable minority opted for one of the wall-mounted ones, maybe because of local electrical practices. Those who chose the correct option usually linked the reason to the fact that nylon is a poor conductor, and thus scored some credit, but hardly any referred to the cause of the whole problem, namely that water is a conductor and condensation in the switch could lead to a shock when any of the others are touched.

(d) Connecting the three lamps in parallel posed no problems for most candidates, although a small number spoiled their attempts by adding an extra wire across the right-hand lamp, thus shorting them all out. Somewhat more of a problem was the position of the switch, which some missed out altogether. Clearly the switch had to be in series with the lamp combination and the mains supply. Some candidates put it in parallel with the supply and therefore lost credit.

Question 11

(a) The deflection of electron beams in electric fields has clearly been taught to most candidates. There were relatively few who failed to show at least an initial downward deflection, even if some of these then lost credit for then showing the beam bending upwards. The quality of the shape of the downward path frequently causes credit to be lost. From the instant the beam enters the region between the plates to the instant it leaves, the path should bend smoothly down. The precise shape of the curve was not expected, as long as it curved all the way. At the instant the beam leaves the field, it stops curving and continues in a straight line in whatever direction it was travelling at that instant. Many candidates showed the beam doing an abrupt change of direction as it entered the field and then continuing straight on. Others showed a curve between the plate, but not starting until somewhere near the middle of the plates. Yet others showed a curve between the plates that continued curving in the region beyond the plates. These deficiencies may have been due to ignorance, or maybe lack of drawing skills, but the question clearly said "carefully draw....".

(b) Many clearly knew how the path would change, but other answers were too ambiguous to be awarded credit.

Question 12

There was a lot of information to be absorbed from the table. Candidates are therefore to be complimented on the fact that so many of them were able to answer all or nearly all parts of this answer correctly.

PHYSICS

Paper 0625/22
Core Theory

Key Messages

To score well in this paper, candidates need to be able to show a sound understanding of topics throughout the syllabus and make simple calculations where needed.

General comments

Candidates who are successful on this paper are those who show a competence across the whole range of topics tested. There were some candidates who performed very well in all questions, which indicates that they had been well-prepared.

For the majority of candidates, however, there was a tendency to be able to answer parts of questions, but rarely to be able to show full understanding of all parts of questions. Many candidates did not have a clear enough knowledge of the topics covered in **Questions 3**, **9**, **10** and **11**. Elsewhere too, many candidates showed gaps in what should be regarded as basic and "straightforward recall" topics, for example, the energy question, **Question 4**. Candidates need to check that their answer is appropriate to the question, as sometimes irrelevant statements were seen. Candidates are expected to be able to adapt their knowledge to questions in an unfamiliar setting, rather than reproducing standard statements which do not fit the particular question.

There were more answers left blank than has usually been the case, but candidates coped adequately with the mathematics, in questions where they knew the physics.

In this paper, candidates are not penalised for poor writing, poor language skills or poor presentation, but credit cannot be awarded if an answer simply cannot be read unambiguously. There were quite a few scripts that fell into this category. It is appreciated that writing in a foreign language, especially one with a different script, makes things difficult for some candidates.

Comments on specific questions

Question 1

Most candidates could recognise the two sections of the journey and calculate the distance travelled by the truck in section BC. However, very few were able to calculate the distance in section CD. Candidates should be encouraged to show their working; those who did indicate how they had attempted to find the distance were able to score some credit even if their final answer was incorrect. The majority could complete the graph, to show the last 30 s of the journey.

Question 2

Very few candidates realised that the 76 cm, printed alongside the barometer, represented the atmospheric pressure. A similar number obtained the differential pressure of the gas by subtracting 50 from 60, but at least as many subtracted 50 from 80. Very few candidates then added either of these answers to the atmospheric pressure. The changes in the mercury levels in **(c)** were often given the wrong way round, and quite a few candidates tried to answer in terms of gas or vacuum volumes or pressures, which clearly did not answer the question.

Question 3

Few candidates were able to answer **(a)** and **(b)** correctly; many didn't realise that the angle of tilt would be the same, whether the block alone was tilted, or both the board and the block. A large proportion of answers to **(d)** did not relate at all to the answer given for **(c)**. Some of these correctly mentioned the change in the position of the centre of mass, but this was not what was asked.

Question 4

This question tested work, energy and power in a basic way. It was, however, poorly answered by many candidates, with some answers bearing no relationship to the question.

Question 5

Questions on waves often cause candidates to struggle, but many, on this occasion, were able to score reasonable credit. Almost all candidates knew where the stones were hitting the water, and most made a reasonable attempt at the shape of the wave in **(b)**. It is quite difficult to draw shapes such as sine waves, so quality of drawing was dealt with generously. Many candidates drew the wave very well indeed. Many stated that the speed of the wave increased or decreased, but a good proportion of candidates were able to spot that the wave speed was constant. A few even correctly explained their reasoning, which was good but not needed. Very few, however, realised that the speed was the same in all directions (circular waves).

Question 6

(a) The correct answer was rarely given here. The meaning of "fixed points" is fundamental to thermometers, and must be known by candidates.

(b) Many answers, such as "it increases" are meaningless in this context, as it is unclear as to what increases; unfortunately, this was a very common type of answer. Candidates should be advised to think carefully about what they are writing, and ensure that their answer really says what they intend it to say. In **(ii)**, many answered in such a way as to suggest that they knew the answer, but did not actually say what is <u>seen</u> happening, as asked by the question.

(c) Not all candidates could identify –12 °C on the scale. Some thought it would be in the bulb, some put it at +12 °C, while some clearly thought the thermometer would not go lower than –10 °C, and showed the arrow there.

Question 7

(a) Although there were a few unlikely suggestions, most candidates were aware that to reflect sound, a large obstacle of some sort is required.

(b) Answers were often too vague to be awarded credit.

(c) The ability to calculate speed from distance and time was good, but many candidates forgot to double the distance, to cover "there and back". Many answers were irrelevant, and answers along the lines of "she might not have used the watch properly" were unacceptable.

Question 8

(a) Most candidates had an understanding that the molecules are vibrating, but answers tended to move on to molecules hitting things or the molecules themselves expanding. There was little understanding about molecules moving further apart or about amplitude of vibrations increasing. Some candidates indicated that they thought the molecules only started vibrating once the heating started.

(b) (c) Many candidates had clearly been taught examples where expansion is involved, and there were some very good descriptions and explanations, and in one or two cases excellent diagrams. However, many could not distinguish between the case where expansion is a problem that has to be dealt with, and the case where expansion is taken advantage of and is useful. For example, it is not useful that railway lines expand in hot weather, but many treated it as if it were a good thing that gaps have to be left between sections of rail. It should be noted that the question specifically stated expansion or contraction of a solid, so descriptions of the behaviour of liquid in glass thermometers or gas in balloons were not acceptable.

Question 9

As on other occasions, it is clear that many candidates do not fully understand electromagnetic induction. Most were able to recognise that the needle would move, for which they received credit. Very few, however, knew that the deflection was momentary or that the deflection would be the other way as the magnet was removed. The majority of candidates thought that the needle went to one side as the magnet went in, and returned to zero as the magnet came out. Many answers to **(c)** were irrelevant, but a few mentioned a current or a voltage and some used the word “induced”.

Question 10

This problem was perhaps slightly more demanding than others on electric circuits. However, no physics was involved that was beyond the syllabus. Many candidates did not correctly recall the relationship between resistance and current; many times $I = VR$ or $I = R/V$ was quoted. Similarly, very few added $5\,\Omega$ and $15\,\Omega$ to get the answer to **(c)**. Generally, this question was poor answered.

Question 11

Many candidates are very weak when it comes to describing procedures in a clear and systematic manner; candidates need to be trained how to give a clear answer. Diagrams of the experimental arrangement rarely included any sort of detector, and almost as rarely any actual source of the radiation, giving simply two rays appearing from one side and striking a selection of absorbers. Few candidates were able to describe the method, which should have included taking readings before and after the insertion of a sheet of paper. The statements of how the results identified the particles were usually no more than statements along the lines of “alpha cannot pass through paper.” Appropriate answers referred to the readings of the detector. Candidates were rarely able to estimate the half-life from the table. The most common error was to take half the maximum time in the table, namely 40 minutes or occasionally 42 minutes.

Question 12

A good proportion of candidates were able to score well on this question. The most common mistakes were the confusion between nucleus and nucleon, nuclide and neutron in **(a)**, and the inversion of the 4 and 2 in **(b)(iii)**.

PHYSICS

Paper 0625/23

Core Theory

Key Messages

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General comments

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For the majority of candidates, however, there was a tendency to be able to answer parts of questions, but rarely to be able to show full understanding of all parts of questions. Many candidates did not have a clear enough knowledge of the topics covered in **Questions 3**, **9**, **10** and **11**. Elsewhere too, many candidates showed gaps in what should be regarded as basic and "straightforward recall" topics, for example, the energy question, **Question 4**. Candidates need to check that their answer is appropriate to the question, as sometimes irrelevant statements were seen. Candidates are expected to be able to adapt their knowledge to questions in an unfamiliar setting, rather than reproducing standard statements which do not fit the particular question.

There were more answers left blank than has usually been the case, but candidates coped adequately with the mathematics, in questions where they knew the physics.

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This question tested work, energy and power in a basic way. It was, however, poorly answered by many candidates, with some answers bearing no relationship to the question.

Question 5

Questions on waves often cause candidates to struggle, but many, on this occasion, were able to score reasonable credit. Almost all candidates knew where the stones were hitting the water, and most made a reasonable attempt at the shape of the wave in **(b)**. It is quite difficult to draw shapes such as sine waves, so quality of drawing was dealt with generously. Many candidates drew the wave very well indeed. Many stated that the speed of the wave increased or decreased, but a good proportion of candidates were able to spot that the wave speed was constant. A few even correctly explained their reasoning, which was good but not needed. Very few, however, realised that the speed was the same in all directions (circular waves).

Question 6

(a) The correct answer was rarely given here. The meaning of "fixed points" is fundamental to thermometers, and must be known by candidates.

(b) Many answers, such as "it increases" are meaningless in this context, as it is unclear as to what increases; unfortunately, this was a very common type of answer. Candidates should be advised to think carefully about what they are writing, and ensure that their answer really says what they intend it to say. In **(ii)**, many answered in such a way as to suggest that they knew the answer, but did not actually say what is <u>seen</u> happening, as asked by the question.

(c) Not all candidates could identify –12 °C on the scale. Some thought it would be in the bulb, some put it at +12 °C, while some clearly thought the thermometer would not go lower than –10 °C, and showed the arrow there.

Question 7

(a) Although there were a few unlikely suggestions, most candidates were aware that to reflect sound, a large obstacle of some sort is required.

(b) Answers were often too vague to be awarded credit.

(c) The ability to calculate speed from distance and time was good, but many candidates forgot to double the distance, to cover "there and back". Many answers were irrelevant, and answers along the lines of "she might not have used the watch properly" were unacceptable.

Question 8

(a) Most candidates had an understanding that the molecules are vibrating, but answers tended to move on to molecules hitting things or the molecules themselves expanding. There was little understanding about molecules moving further apart or about amplitude of vibrations increasing. Some candidates indicated that they thought the molecules only started vibrating once the heating started.

(b) (c) Many candidates had clearly been taught examples where expansion is involved, and there were some very good descriptions and explanations, and in one or two cases excellent diagrams. However, many could not distinguish between the case where expansion is a problem that has to be dealt with, and the case where expansion is taken advantage of and is useful. For example, it is not useful that railway lines expand in hot weather, but many treated it as if it were a good thing that gaps have to be left between sections of rail. It should be noted that the question specifically stated expansion or contraction of a solid, so descriptions of the behaviour of liquid in glass thermometers or gas in balloons were not acceptable.

Question 9

As on other occasions, it is clear that many candidates do not fully understand electromagnetic induction. Most were able to recognise that the needle would move, for which they received credit. Very few, however, knew that the deflection was momentary or that the deflection would be the other way as the magnet was removed. The majority of candidates thought that the needle went to one side as the magnet went in, and returned to zero as the magnet came out. Many answers to **(c)** were irrelevant, but a few mentioned a current or a voltage and some used the word “induced”.

Question 10

This problem was perhaps slightly more demanding than others on electric circuits. However, no physics was involved that was beyond the syllabus. Many candidates did not correctly recall the relationship between resistance and current; many times $I = VR$ or $I = R/V$ was quoted. Similarly, very few added $5\,\Omega$ and $15\,\Omega$ to get the answer to **(c)**. Generally, this question was poor answered.

Question 11

Many candidates are very weak when it comes to describing procedures in a clear and systematic manner; candidates need to be trained how to give a clear answer. Diagrams of the experimental arrangement rarely included any sort of detector, and almost as rarely any actual source of the radiation, giving simply two rays appearing from one side and striking a selection of absorbers. Few candidates were able to describe the method, which should have included taking readings before and after the insertion of a sheet of paper. The statements of how the results identified the particles were usually no more than statements along the lines of “alpha cannot pass through paper.” Appropriate answers referred to the readings of the detector. Candidates were rarely able to estimate the half-life from the table. The most common error was to take half the maximum time in the table, namely 40 minutes or occasionally 42 minutes.

Question 12

A good proportion of candidates were able to score well on this question. The most common mistakes were the confusion between nucleus and nucleon, nuclide and neutron in **(a)**, and the inversion of the 4 and 2 in **(b)(iii)**.

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General comments

There was a wide range of marks on this paper, but a large majority of candidates had clearly been well taught and prepared. From the highest to the lowest scoring candidates there were very few unanswered questions.

Because the recall of formulae is generally good, candidates start off on the right footing and tend to gain credit more readily in numerical work than in answers where no numerical work is involved. In the type of question requiring the application of ideas in unfamiliar situations, and verbal explanations, candidates in general are less sure of their ground and are more likely to set off on the wrong track.

Candidates showing the highest level of achievement clearly absorb factual material extremely well and are also able to apply their knowledge with some confidence in unfamiliar situations, and write the best explanations. The middle range of candidates showed strength in recall, but struggled harder with expressing their thoughts clearly. Other candidates often had great difficulty both in recall and in their ability to write answers which convey their ideas.

The majority of candidates showed by their knowledge and skills that they had been correctly entered for this Extended Theory paper. However, a significant minority of candidates found the subject matter and level of some questions so difficult that these questions were inaccessible to them, and they would have been better entered for the Core 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 sufficiently.

Comments on specific questions

Question 1

(a) Most answers correctly stated 1.8 s as being the most frequently given value, or 1.81 s as the mean of the values. Credit was only awarded, however, when the value was accompanied by a correct supporting explanation.

(b) Most candidates received half of the available credit. This was awarded for the suggestion of timing a number of successive oscillations, and dividing the time by the number of oscillations. The remaining credit could be gained for a number of possible suggestions: repeating the above and finding the average, setting or checking the zero of the stopwatch, using a fixed reference point for accurate timing or for showing knowledge of what is meant by an oscillation. Some of the best answers used bullet points in the form of a set of instructions.

Question 2

(a) Most candidates could answer at least one of the three parts correctly, with many gaining credit for each part. The most common errors were in **(ii)** to describe the motion as acceleration instead of constant speed or uniform speed, and in **(iii)** to describe the motion as decreasing acceleration instead of deceleration. Speeding up and slowing down were acceptable alternatives to acceleration and deceleration.

(b) (i) Total distance / total time or distance / time or 400 / 60 were all credited and the remaining credit could be earned by giving the correct answer of 6.7 m / s or a number which gave this value if reduced to two significant figures.

(ii) This rather more demanding part of the question was nevertheless answered well by a good number of candidates. Recognition that the steepest part of the graph was required gained credit, with further credit available for correct data taken from the graph and a correct calculation. The most common error was to calculate the mean speed over the first 45 seconds.

Question 3

(a) A large variety of examples were seen, most of which were valid. Unacceptable choices included nuclear power stations, and electrical generators, unless in this case it was described as driven by a relevant type of fuel.

(b) (i) Calculations using $P = IV$ and the correct answer with its unit enabled a large majority to be awarded full credit.

(ii) A minority of candidates found difficulty in applying the idea of efficiency and could not calculate the kinetic energy. Other correct calculations quoted the wrong unit.

(iii) **1.** Very few were unsuccessful in calculating the mass of water.

2. The requirement was to equate the potential energy gained to the kinetic energy lost, that is to *mgh* with the answer to **(b)(ii)**. Some candidates confused *mgh* with the formula for pressure ρgh and could not be rewarded.

Question 4

(a) Candidates needed to take careful note of the units given in the question. Dividing 90 N by 4.8 cm^2 gave the answer in N / cm^2. Most did the calculation correctly but many candidates automatically wrote down Pa as the unit. Conversion of cm^2 to m^2, if attempted, was often unsuccessful.

(b) It was sufficient to state that the area of Y was bigger. Some candidates found other correct ways of expressing the same idea, with the best candidates including a reference to the equation for pressure.

(c) There were few correct responses to this more difficult question. One approach was to refer to the volume of oil pushed by pistons X and Y being the same, so that piston Y, with the larger area, had to move less distance. The other approach was to state that the work done by X had to equal the work done on Y, so that with the larger force Y had to move less distance. One type of wrong suggestion involved the idea that the pressures on X and Y were different, contradicting the statement in the question.

(d) This was less problematical than **(c)** with many references to the fact that air is compressible, so that less pressure or force is transmitted to Y, or that Y would move a smaller distance than required. Wrong suggestions involved the idea that oil is compressible.

Question 5

(a) (i) Various examples of changes of state were accepted, as long as they were equivalent to gas to liquid, or liquid to solid, or an example of either. Evaporation was accepted as long as the answer in **(ii)** was 'fall in temperature' or 'cools down'.

(ii) A significant number of candidates suggested a fall in temperature, perhaps on the basis that the material cools before the change of state.

(b) Some answers gave a definition of specific heat capacity instead of thermal capacity, for which credit could not be awarded.

(c) (i) Most candidates stated and used the formula correctly.

(ii) Fewer candidates than expected realised that the thermal energy gained by the ice was the same as the thermal energy lost by the water.

(iii) Candidates who used 21 000 J or the incorrect value from **(ii)**, and then used $H = mL$ correctly, were awarded full credit.

Question 6

This was a question in which candidates were expected to apply their knowledge to an unfamiliar situation. In many cases, candidates did not realise that the general theme of the question was the expansion of solids and liquids.

(a) (i) The initial fall of the water in the tube was frequently explained in terms of evaporation of water or change of pressure of the water. Few grasped the idea that the glass absorbed heat and expanded first, for which full credit could be given.

(ii) This part was better answered, with candidates correctly realising that the heating of the water and its expansion was responsible for the rise. Following incorrect responses in **(i)**, however, many candidates here continued with the same ideas and therefore could not be awarded credit.

(iii) Few candidates, including some who had gained full credit so far, now suggested that water expands more than glass.

(b) The most common correct answer was that of making the glass tube narrower. Many of the alternative suggestions made were unclear or incorrect, such as making the glass thinner, or making the tube longer.

Question 7

(a) Only answers referring to up and down motion of a molecule, or its vibration perpendicular to the wave's direction were rewarded. Some candidates described longitudinal motion.

(b) (i) Some excellent compass-drawn and free-hand attempts were seen. Full credit was awarded for circular arcs with approximately the same spacing as the incident waves and of sufficient angular spread. Many other less accurate sketches gained partial credit.

(ii) The term *diffraction* is generally well known.

(c) A very large majority of candidates calculated the frequency correctly.

Question 8

(a) (i) The only acceptable answer was 'electrons'.

(ii) Most answers showed the correct distribution of + and – signs in the sphere. Signs shown just outside the sphere were also accepted.

(iii) The three steps in the correct order (earth the sphere; remove the earth connection; remove the rod) were required and each gained credit. Touching the sphere, implying brief contact with the sphere, was taken as equivalent to the first two steps. Several answers only mentioned the first step, ignoring the requirement for even distribution of the positive charge.

(b) (i) Many candidates quoted the correct formula. Of these many did not convert 2 minutes to seconds or made other errors, and so did not gain full credit.

(ii) A good proportion of candidates quoted the formula for energy and used it correctly, sometimes with the error in **(i)** carried forward, to obtain full credit.

Question 9

This question revealed a good deal of misunderstanding about the distribution of current in a circuit and the application of the different forms of $I = V/R$ to resistors or a combination of resistors in a circuit.

(a) (i) The expression $I_1 = I_2 + I_3$ was required. To state that I_1 is shared between I_2 and I_3 was insufficient.

(ii) The misconception that I_1 is greater than I_4 was frequently seen.

(b) (i) Many candidates did not appreciate that the p.d. across two resistors in parallel is the same as the p.d. across either one of them. Consequently, although the value of the current I_2 was given, very few applied $V = IR$ to the 3.0 Ω resistor.

(ii) A correct answer to **(i)** usually led to a correct answer being obtained here. Many candidates gained partial credit for using $I = V/R$ or one of its other forms. Full credit was given to candidates substituting an incorrect value from **(i)**, but this was rarely seen.

(iii) This was the part of the question intended to be more demanding. It was expected that most candidates would calculate the combined resistance of the two resistors in parallel (1.2 Ω) and many did this successfully. Some of these also gained credit for adding I_2 and I_3, possibly with error carried forward from **(b)(ii)**. The last step, using $6.0/I_1$ to calculate the total resistance of the circuit and then subtracting 1.2 Ω, proved the stumbling block for many.

There were other ways of approaching the problem, not involving calculation of the resistance of the parallel combination, and these were also credited.

Question 10

(a) In **(i),** most candidates knew the direction of the field between the poles, but some did not draw the field lines between the poles as required. In **(ii)**, most applied Fleming's left-hand rule correctly.

(b) (i) Many candidates gave as their answer a material that would absorb β-particles, rather than a detector as required.

(ii) The beam of β-particles had to be recognised as a flow of negatively charged particles, and realise that their deflection would be opposite to that of the current-carrying wire given in **(a)(ii)**, or apply Fleming's left-hand rule for current from Q to P. The force had to be expressed as 'out of the paper' or an equivalent expression. 'Upwards', suggested by many, would not suffice as it is ambiguous.

(iii) The requirement here was to state that the β-particles followed a curved path.

(iv) A good proportion of responses gave the required answer.

Question 11

(a) Most candidates could recognise the component as a transistor.

(b) The correct components were identified by many candidates, with a creditable number placing them in the correct gaps. A variable resistor, or a rheostat, were acceptable alternatives to a resistor.

(c) Mention of a thermistor was sufficient for partial credit. For the full credit to be gained the thermistor had to be in gap A, with a resistor or alternative in gap B.

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General Comments

A high proportion of candidates had clearly been well taught and prepared for this paper, and there were very few unanswered questions. There remains the tendency to think less rigorously and logically in non-numerical questions than in numerical questions. Equations were generally well known.

Often candidates had been well taught how to apply equations to fairly standard situations. On occasions, when asked to apply their knowledge to a new situation, they could become confused and display 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.

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Question 1

(a) (i) The majority of candidates scored full credit. However, a significant number stated that the graph was describing acceleration, despite stating that the speed was constant at 2.5 m / s.

(ii) Good candidates showed the required smooth line curving upwards. Many weaker candidates simply showed a straight line either as a continuation of the original, or with a different gradient.

(b) Many candidates scored credit here, but others had not understood what was required. The question clearly asked about the graph, but often candidates wrote about the object and so failed to score. Candidates should be encouraged to read all questions carefully before answering.

(c) This question required a correct demonstration of the shape of the graph and careful, accurate drawing. It is expected that candidates' graph work will be accurate to within half a small square. The majority of candidates were awarded credit for drawing a horizontal straight line for the first part, but not as many managed to gain the credit for showing the required acceleration over the next two seconds.

(d) Again, as in part **(b)**, many candidates described a stationary object rather than referring to a horizontal straight line on the *x*-axis of the graph as required.

Question 2

(a) There were many correct answers, but a significant number failed to evaluate a correct moments equation. The typical errors were confusion between mass and weight and applying the wrong moment arm to the wrong force. Invariably it was the candidates who set out their work in a systematic manner who reached the correct answer.

(b) Only a minority of candidates answered this correctly. Often the weight of either the counterweight or the bird was quoted, rather than the sum of the two.

(c) Very few candidates realised that once the sculpture was balanced, it would remain so in any position, since the centre of mass is at the pivot. Often candidates followed up an incorrect initial statement with something correct like "moments balance" or "in equilibrium". Examiners gave credit for these correct explanations despite the contradiction with the original statement. Statements confusing forces and moments were often seen, candidates seeing the words as interchangeable, but these did not gain credit.

Question 3

(a) The majority of candidates scored full credit. There was an occasional unit error, incorrect evaluation or, more rarely, the use of an expression other than *mgh* to calculate potential energy.

(b) Many candidates produced good answers to score full credit. They had learnt well how to apply the efficiency equation in a practical situation such as this. Weaker candidates often suffered from their own confused setting out; in cases where there is no explanation of the working, and the numbers are incorrect, it is not possible for the Examiners to recognise the intermediate stages and award any credit.

(c) Nearly all candidates, including some of the more able, failed to give the correct direction for the flow of water, often merely stating 'up' or 'down' when the water can only flow horizontally through the turbine. This suggests again that they did not read the question carefully and answered what they thought was asked. For part **(ii)** many candidates thought that an a.c. generator would suffice for explaining that the turbine/generator needed to be able to rotate in either direction.

Question 4

Most candidates scored reasonably on this question but many in parts **(a)** and **(b)** did not realise that angles of incidence, reflection and refraction are measured from the normal.

(a) The answers were generally correct.

(b) The Snell's Law equation was generally known as was the need to apply it to critical refraction. Some candidates found it harder to apply the equation in a practical situation.

(c) The point of this question is that the different colours are dispersed on refraction but not reflection. Many correct answers were seen but many candidates thought that the different colours had different angles of reflection or that the refracted red ray would still graze the external surface of the block.

(d) The majority scored full credit, but there were a number of candidates who did not appreciate the need for careful diagrams. Candidates might have the right general idea but lost credit due to graphical inaccuracy. Some candidates drew the prism upside down, using the prism as if it was a mirror, rather than for total internal reflection.

Question 5

Most candidates found the descriptive nature of this question difficult to deal with. They did not always realise the need to work as logically with their explanations in words as they would with a numerical answer. Careful reading of the question was again required, which leads to answers in terms of waves and wavefronts. Often candidates lost some of the available credit because they gave answers in terms of rays and whether or not they bent towards the normal. Good candidates were familiar with the material in ***Section 3.1*** of the Syllabus where they are required to "interpret reflection, refraction and diffraction using wave theory."

(a) Most candidates gave a correct answer for **(i)**, but the explanations in **(ii)** were often weak.

(b) Stronger candidates, in particular, did much better on this part but credit was still lost due to imprecise wording. One example is that the statement "the water is level in both parts" might have implied the correct idea in a candidate's mind but does not actually say anything about the depth of the water.

Question 6

In parts **(a)** and **(b)** many candidates lost credit by not answering the question asked about the drying times of the T-shirts. The statement "water evaporates faster in a breeze" does not state which T-shirt dries the quickest, and a number of candidates did not clearly identify the T-shirt they meant. There are different conventions in different parts of the world for working from right to left or from left to right. The description "first T-shirt" is ambiguous unless the diagram is labelled.

(a) This was generally well answered with a good explanation. A common misconception was that the wind gives the liquid water molecules more kinetic energy to help them evaporate.

(b) Again this was generally well answered. The link between increased area and shorter drying time was understood and explained.

(c) Mostly there were good answers in terms of the heat required for evaporation. Candidates did not score credit for vague statements about a cooling effect.

Question 7

(a) Candidates generally scored well on both parts.

(b) (i) Only the stronger candidates scored here. Straight radial lines were expected, with inward arrows, drawn neatly and carefully at least to within a few millimetres of the point.

(ii) Many answers showed a reasonable awareness of what was required but credit was often lost by a lack of precision in the answer, such as not mentioning direction or answering in terms of a magnetic field.

Question 8

This was a typical example of a question where many candidates were familiar with the physics of the situation but did not express their answers in a logical manner answering the question asked. This was particularly the case in part **(b)** where there was often talk about fields, induction of current and forces but it was not all linked together in a consequential way. Alternatively attempts to use Lenz's Law, whether mentioned or not, were frequently far too vague.

(a) In both parts there was an appreciation that something would show on the milliammeter. 'Faster' was often given in part **(ii)** and it was impossible to know if candidates really meant 'greater'. Although field lines being cut was often understood for **(i)**, a greater rate was not always seen for **(ii)**. In fact a significant number of candidates thought nothing would happen as the magnet speeds up inside the solenoid.

(b) Strong candidates gave a logical explanation that the induced current causes a magnetic field in the coil which interacts with the magnetic field of the magnet, causing an upward force. It was possible to score full credit with a Lenz's law approach but it was seldom achieved, usually because it was not appreciated that the force is to do with the induced current.

Question 9

(a) Most candidates scored well in this part. The most common error was confusion between the voltage and the resistance of the whole circuit and that of one lamp.

(b) There were many good attempts at this difficult question. Usually if candidates calculated the new resistance of each lamp, they went on to gain further credit. Many candidates calculated the theoretical number of working lamps as 31.7, sometimes rounded to 32, and then stopped. They did not read the question carefully enough, which asked for the number of failed lamps.

Those candidates who worked with the original resistance of a lamp as $8\,\Omega$, and made no further error, still gained the majority of the available credit as long as their working was clear. Many candidates made this or another mistake but the setting out was confused and unexplained so the Examiner simply could not see whether or not there was anything of merit in the working.

Question 10

Overall this was a well answered question. A small minority of the less able candidates appeared not to recall the topic of digital electronics at all.

(a) (b) These parts were usually answered correctly.

(c) The majority of candidates scored here. The most common error was carelessness in drawing. Typically one side of the OR gate was drawn correctly but the other side was like that of an AND gate; such an ambiguous answer did not gain credit. Also many candidates appeared not to have read in part **(ii)** that the gates should be connected.

(d) This part was usually answered correctly.

Question 11

(a) This was another situation when many candidates simply wrote in vague terms about the situation and did not address the question asked. Strong candidates recognised that the sample had nearly all decayed so the variation was caused by background radiation.

(b) Many candidates gained almost full credit on this question although even many of the stronger candidates did not recognise the need to use the background count to obtain the correct answer. Weaker candidates struggled, producing a wide variety of incorrect approaches suggesting that they did not understand the concept of half-life. This was another situation where possible merit in responses could not be recognised because of confused and unexplained setting out.

(c) Many answers only explained how the suggested safety precaution affected one type of radiation and not both. A lot of candidates seemed to think that the forceps themselves had a shielding effect, rather than merely increasing the separation in air between the source and the researcher. Few received more than minimal credit.

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(d) The majority scored full credit, but there were a number of candidates who did not appreciate the need for careful diagrams. Candidates might have the right general idea but lost credit due to graphical inaccuracy. Some candidates drew the prism upside down, using the prism as if it was a mirror, rather than for total internal reflection.

Question 5

Most candidates found the descriptive nature of this question difficult to deal with. They did not always realise the need to work as logically with their explanations in words as they would with a numerical answer. Careful reading of the question was again required, which leads to answers in terms of waves and wavefronts. Often candidates lost some of the available credit because they gave answers in terms of rays and whether or not they bent towards the normal. Good candidates were familiar with the material in ***Section 3.1*** of the Syllabus where they are required to "interpret reflection, refraction and diffraction using wave theory."

(a) Most candidates gave a correct answer for **(i)**, but the explanations in **(ii)** were often weak.

(b) Stronger candidates, in particular, did much better on this part but credit was still lost due to imprecise wording. One example is that the statement "the water is level in both parts" might have implied the correct idea in a candidate's mind but does not actually say anything about the depth of the water.

Question 6

In parts **(a)** and **(b)** many candidates lost credit by not answering the question asked about the drying times of the T-shirts. The statement "water evaporates faster in a breeze" does not state which T-shirt dries the quickest, and a number of candidates did not clearly identify the T-shirt they meant. There are different conventions in different parts of the world for working from right to left or from left to right. The description "first T-shirt" is ambiguous unless the diagram is labelled.

(a) This was generally well answered with a good explanation. A common misconception was that the wind gives the liquid water molecules more kinetic energy to help them evaporate.

(b) Again this was generally well answered. The link between increased area and shorter drying time was understood and explained.

(c) Mostly there were good answers in terms of the heat required for evaporation. Candidates did not score credit for vague statements about a cooling effect.

Question 7

(a) Candidates generally scored well on both parts.

(b) (i) Only the stronger candidates scored here. Straight radial lines were expected, with inward arrows, drawn neatly and carefully at least to within a few millimetres of the point.

(ii) Many answers showed a reasonable awareness of what was required but credit was often lost by a lack of precision in the answer, such as not mentioning direction or answering in terms of a magnetic field.

Question 8

This was a typical example of a question where many candidates were familiar with the physics of the situation but did not express their answers in a logical manner answering the question asked. This was particularly the case in part **(b)** where there was often talk about fields, induction of current and forces but it was not all linked together in a consequential way. Alternatively attempts to use Lenz's Law, whether mentioned or not, were frequently far too vague.

(a) In both parts there was an appreciation that something would show on the milliammeter. 'Faster' was often given in part **(ii)** and it was impossible to know if candidates really meant 'greater'. Although field lines being cut was often understood for **(i)**, a greater rate was not always seen for **(ii)**. In fact a significant number of candidates thought nothing would happen as the magnet speeds up inside the solenoid.

(b) Strong candidates gave a logical explanation that the induced current causes a magnetic field in the coil which interacts with the magnetic field of the magnet, causing an upward force. It was possible to score full credit with a Lenz's law approach but it was seldom achieved, usually because it was not appreciated that the force is to do with the induced current.

Question 9

(a) Most candidates scored well in this part. The most common error was confusion between the voltage and the resistance of the whole circuit and that of one lamp.

(b) There were many good attempts at this difficult question. Usually if candidates calculated the new resistance of each lamp, they went on to gain further credit. Many candidates calculated the theoretical number of working lamps as 31.7, sometimes rounded to 32, and then stopped. They did not read the question carefully enough, which asked for the number of failed lamps.

Those candidates who worked with the original resistance of a lamp as $8\,\Omega$, and made no further error, still gained the majority of the available credit as long as their working was clear. Many candidates made this or another mistake but the setting out was confused and unexplained so the Examiner simply could not see whether or not there was anything of merit in the working.

Question 10

Overall this was a well answered question. A small minority of the less able candidates appeared not to recall the topic of digital electronics at all.

(a) (b) These parts were usually answered correctly.

(c) The majority of candidates scored here. The most common error was carelessness in drawing. Typically one side of the OR gate was drawn correctly but the other side was like that of an AND gate; such an ambiguous answer did not gain credit. Also many candidates appeared not to have read in part **(ii)** that the gates should be connected.

(d) This part was usually answered correctly.

Question 11

(a) This was another situation when many candidates simply wrote in vague terms about the situation and did not address the question asked. Strong candidates recognised that the sample had nearly all decayed so the variation was caused by background radiation.

(b) Many candidates gained almost full credit on this question although even many of the stronger candidates did not recognise the need to use the background count to obtain the correct answer. Weaker candidates struggled, producing a wide variety of incorrect approaches suggesting that they did not understand the concept of half-life. This was another situation where possible merit in responses could not be recognised because of confused and unexplained setting out.

(c) Many answers only explained how the suggested safety precaution affected one type of radiation and not both. A lot of candidates seemed to think that the forceps themselves had a shielding effect, rather than merely increasing the separation in air between the source and the researcher. Few received more than minimal credit.

PHYSICS

Paper 0625/04

Coursework

General comments

The candidates at the majority of Centres were given many opportunities to demonstrate their practical skills using a varied range of tasks from different areas of the physics syllabus. Clearly a large amount of good work has been completed by teachers and candidates. Most of the work samples illustrated clear, annotated marking and comments. These were very helpful during the moderation process.

It is pleasing to see that points made in previous reports have been noted. There are still, however, some Centres that do not provide clear mark schemes for skill area C1. This makes it difficult to clarify how the assessment criteria were applied and how the candidates achieved the awarded credit.

PHYSICS

Paper 0625/51
Practical Test

Key Messages

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

The paper should be read carefully so that written answers address those specific points referred to in the questions rather than more general aspects of the same topic. Drawings, such as ray-traces, diagrams and graphs, need to be carried out with care. Mathematical answers need to be expressed to an appropriate number of significant figures and with a correct unit where applicable.

General comments

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

- graph plotting
- understanding the significance of the best-fit graph line
- determination of the gradient of a straight graph line
- drawing ray diagrams
- tabulation of readings
- manipulation of data to obtain results
- drawing conclusions
- understanding of the concept of results being equal within the limits of experimental accuracy
- dealing with possible sources of inaccuracy
- control of variables
- accurate measurements
- choice of the most effective way to use the equipment provided

The full range of available credit was seen on this paper. Most candidates were well prepared and it was pleasing to see that the range of practical skills being tested proved to be accessible to the majority. All parts of every practical test were attempted and there was no evidence of candidates running short of time.

Most of the candidates were able to follow instructions, record observations clearly and perform calculations accurately and correctly. There was evidence that some candidates may not have had the use of a calculator. Units were well known and almost invariably included, writing was 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. Explanations and justifications should refer to practical details or results rather than theory.

It is expected that numerical answers will be expressed to a number of decimal places or significant figures which is appropriate to the measurements carried out by the candidate, and this was demonstrated in many good responses. The use of a ‘recurring’ symbol or the expression of a numerical answer in fractional rather than decimal form must be avoided.

The choice of an appropriate scale to use when constructing graphs causes difficulty for many candidates, as does the drawing of lines of best fit. This applies particularly when the range of one of the variables is limited, and a restricted scale on one of the axes would allow candidates to make better use of the allowed space on the grid.

Many candidates will have prepared for the examination (very sensibly) by working through some past papers. However, in some cases candidates gave learned answers that would have been correct in a similar question from a previous session, but were not appropriate to this question paper.

If a mistake has been made and the candidate wishes to correct the response, they should be encouraged to cross out the first answer completely and to re-write their answer clearly, rather than trying to overwrite the answer, so that there is no ambiguity. If the answer cannot be read by the Examiner, credit cannot be awarded.

Comments on specific questions

Question 1

(a) An appropriate volume of water was almost invariably poured into the test-tube, instructions were followed, and a sensible value for the volume V_G of the glass of the test-tube obtained. Where credit was lost, it was usually for the omission of units for the volume of the glass.

(b) The given instructions were usually followed, and a sensible estimate of the volume of air in the test tube, $V_{A,}$ obtained.

(c) The volume of water that the test-tube could hold, V_W, was found by all candidates, and the majority of answers were within $\pm 5\,cm^3$ of the candidates' value of V_A, which was the experimental tolerance allowed for this task.

(d) Many candidates ignored the statement in the stem that the experiments had been carried out correctly and carefully, and blamed lack of care on their behalf in carrying out the experiment, as being the main reason for the discrepancy between the two answers. No credit was given for this. The more able candidates evaluated the experiment and gave sensible suggestions for the difference in values. Creditworthy answers included: the test-tube being pushed into the water too far/not far enough; water rising into the test-tube; water remaining in the test-tube/measuring cylinder.

Question 2

(a) Most candidates recorded a sensible value for room temperature.

(b) The table was completed correctly by the majority of candidates, although the units for the column headings were sometimes missing, despite the instruction in **(iv)**. Where they had been completed, the unit for temperature was occasionally incorrect. As the thermometer was moved towards the lamp, the temperature recorded by the thermometer increased, so it was very surprising to see temperatures given in the table by a sizeable minority of candidates, staying the same, or even decreasing.

(c) The majority of candidates recorded a value for θ_V which was greater than θ_H. When recording the temperature difference, many candidates seemed uncertain which table value of temperature they should use.

(d) This question, which concerned the selection of conditions to keep constant when repeating the experiment, proved to be a good discriminator. Only the most able candidates suggested that it would be important to keep the temperature of the laboratory constant and to control draughts.

(e) Only a small minority of candidates suggested that it would be necessary to wait between taking readings to ensure that the result would be reliable.

Question 3

(a) The table was usually completed, but candidates should be aware that if they insert incorrect values into the table and wish to correct them, the Examiner must be able to read unambiguously the new value inserted. It is important to cross out the old value completely. Units were sometimes omitted from the table headings, or, when included, were sometimes incorrect. Candidates should consider carefully the number of significant figures / decimal places they use when inserting values for current and voltage.

(b) There were many excellent attempts at plotting the given graph, which scored full credit. Although the standard of graph plotting continues to get better, for some candidates there is still scope for improvement. The advice is that plotted points should, preferably, be marked with a fine cross. Small dots are acceptable but are often obscured when the line is drawn through them, making it difficult to award credit for correctly plotted values. A larger circle around a small dot to indicate its position is acceptable. Scales should be chosen that allow maximum use of the space supplied by the given grid. If there is scatter in the points, candidates are expected to use their judgement to draw a neat, thin, continuous best-fit line/curve.

(c) The determination of the gradient presented no problem to the majority of candidates, however, a significant number of candidates lost credit because they ignored the instruction to show clearly on their graph how they had obtained the necessary information. Candidates are expected to use at least half the line when drawing their gradient triangle/selecting the coordinates to calculate the gradient.

(d) When quoting a value of the gradient, it is important for candidates to realise that the value should be quoted to no more significant figures than the data they had collected to draw their graph.

Question 4

(a)(b)(c) The majority of candidates ignored the emboldened instruction to move the lens until a clearly focused **enlarged** image was formed on the screen. From the results given, it was obvious that they had obtained a diminished image.

(d)(e)(f) Again, the instructions were ignored by many, and candidates obtained an enlarged image, instead of a diminished one. The focal length of the lens was usually calculated correctly and an answer that lay within an acceptable tolerance was obtained. This was given full credit.

(g) Most candidates turned the lens around and repeated the procedure to arrive at an answer for the focal length that was within ±1 cm of their previous answer. Credit was sometimes lost because the two values of focal length obtained were quoted to a different number of significant figures.

(h) This part proved to be an effective discriminator, with only the better candidates being able to give a sensible justification to match the statement that they had made.

(i) Candidates are frequently asked to describe a sensible precaution to take whilst carrying out an optics experiment. However, very few candidates were able to give an acceptable precaution. Acceptable answers in this particular case included: to carry out the experiment in a darkened room; to move the lens back and forth until the clearest/sharpest image is obtained; to mark the lens holder to show the centre of the lens; to clamp the metre rule to the bench. The avoidance of parallax is acceptable, as long as candidates state what they would do to avoid parallax. The mere mention of the word parallax does not automatically gain credit.

PHYSICS

Paper 0625/52
Practical

Key Messages

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

The paper should be read carefully so that written answers address those specific points referred to in the questions rather than more general aspects of the same topic. Drawings, such as ray-traces, diagrams and graphs, need to be carried out with care. Mathematical answers need to be expressed to an appropriate number of significant figures and with a correct unit where applicable.

General Comments

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

- graph plotting
- understanding the significance of the best-fit graph line
- determination of the gradient of a straight graph line
- drawing ray diagrams
- tabulation of readings
- manipulation of data to obtain results
- drawing conclusions
- understanding of the concept of results being equal within the limits of experimental accuracy
- dealing with possible sources of inaccuracy
- control of variables
- accurate measurements
- choice of the most effective way to use the equipment provided

The general level of competence shown by the candidates was sound. Very few candidates did not attempt all sections of each of the questions and there was no evidence of candidates suffering from lack of time.

Many candidates, who appeared to have had a good level of practical experience, dealt well with the range of practical skills tested. The highest scoring candidates were able to answer those sections involving careful thought about techniques or the significance of results with confidence. A number of candidates, however, produced responses which showed a lack of familiarity with experiments of this type. These candidates struggled to present well thought out conclusions, backed up by evidence. Explanations and justifications should refer to practical details or results rather than theory.

It is expected that numerical answers will be expressed to a number of decimal places or significant figures which is appropriate to the measurements carried out by the candidate, and this was demonstrated in many good responses. The use of a ‘recurring’ symbol or the expression of a numerical answer in fractional rather than decimal form must be avoided.

The choice of an appropriate scale to use when constructing graphs causes difficulty for many candidates, as does the drawing of lines of best fit. This applies particularly when the range of one of the variables is limited, and a restricted scale on one of the axes would allow candidates to make better use of the allowed space on the grid.

Many candidates will have prepared for the examination (very sensibly) by working through some past papers. However, in some cases candidates gave learned answers that would have been correct in a similar question from a previous session, but were not appropriate to this question paper.

If a mistake has been made and the candidate wishes to correct the response, they should be encouraged to cross out the first answer completely and to re-write their answer clearly, rather than trying to overwrite the answer, so that there is no ambiguity. If the answer cannot be read by the Examiner, credit cannot be awarded.

Comments on Specific Questions

Question 1

(a) Most candidates filled in the table accurately and recorded realistic values for the forcemeter readings. To gain full credit, candidates needed to record all the forcemeter readings to a precision of at least 0.2 N.

(b) Most candidates realised that a graph of *F* against *d* should be suggested. Many knew that a straight line would indicate the proportional relationship but few recalled that the line must also pass through the origin.

(c) Candidates who read the question with care realised that the weight of the spirit level would affect the forcemeter reading. They did not need to know anything about the spirit level.

(d) Most candidates sensibly drew a diagram. Some did not score because they tried to explain something unnecessarily complex and impractical. The most straightforward answers involved measuring the height of the rule from the bench at two or more intervals along its length.

Question 2

(a) Most candidates successfully recorded a realistic room temperature with the correct unit, °C.

(b) The majority of candidates recorded the times and temperatures correctly, but some gave room temperature at time 0 s and so lost credit.

(c) Candidates needed to set up the graph axes so that their plots would make best use of the grid both vertically and horizontally. A significant proportion chose a poor vertical scale, but almost all labelled the axes correctly. The plotting was usually correct. Candidates then needed to draw a line that was a good attempt at the best-fit line and not too thick. The candidates' own readings determined whether a straight line or curve was most appropriate. The Examiners gave credit according to the fit with the candidates' plots.

(d) Here candidates needed to consider carefully the aspects of good experimental technique that they had discussed and used during their IGCSE course and apply them to these specific questions. Good answers contained references to constant room temperature, constant initial water temperature and avoidance of draughts. Two suggestions were asked for in the question and candidates should be advised not to make more suggestions than the question requires as they may be penalised for contradictory suggestions.

Question 3

(a) Most candidates gave the potential difference and current values correctly. Some lost credit by not giving the current value to at least two decimal places; recorded values should reflect the precision of the measuring instrument. Most candidates went on to successfully complete the calculation.

(b) The potential difference and current values given here showed that the majority of candidates had successfully rearranged the circuit as instructed. Most candidates obtained a resistance value R_S that was close to $4R_P$.

(c) Most candidates made a correct statement but few justified it by commenting that the values were within (or beyond) the limits of experimental inaccuracy (or words to that effect). Some attempted a theoretical explanation which was not asked for and so did not gain credit.

(d) Many candidates drew the correct diagram using standard symbols. Some candidates drew resistors in place of lamps, or drew a parallel circuit in place of the series circuit required. Full credit was only awarded to those candidates who had successfully recorded the new potential difference and given the L_S value to two or three significant figures.

(e) Credit was given to those candidates who gave the potential difference, current and resistance with the correct units.

(f) Candidates were expected to know from their experience of this type of experiment, and observations made during this particular experiment, that the lamps become hot. This might be expressed by commenting on the brightness of the lamp or that it feels hot to the touch.

Question 4

(a)-(i) This question required candidates to work with care and to be familiar with drawing ray traces in this type of experiment. Most ray traces were drawn neatly and if the candidate drew the lines as instructed, then full credit was awarded. Some candidates lost credit by placing the pins too close together. Candidates need to realise that for good accuracy the pins should be placed as far apart as is practical. In this case the minimum separation to gain credit was 5.0 cm, and the most competent candidates placed their pins with a separation well in excess of 5.0 cm. A significant number of candidates drew their second set of rays on the same side of the normal as the first, not as instructed.

(j) Many candidates successfully calculated the value for refractive index and correctly gave it to two or three significant figures with no unit.

(k) Credit was awarded to those candidates who had demonstrated overall care and consistency in their work by obtaining both refractive index values in the range 1.4 to 1.6.

PHYSICS

Paper 0625/53
Practical

Key Messages

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

The paper should be read carefully so that written answers address those specific points referred to in the questions rather than more general aspects of the same topic. Drawings, such as ray-traces, diagrams and graphs, need to be carried out with care. Mathematical answers need to be expressed to an appropriate number of significant figures and with a correct unit where applicable.

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- control of variables
- accurate measurements
- choice of the most effective way to use the equipment provided

The general level of competence shown by the candidates was sound. Very few candidates did not attempt all sections of each of the questions and there was no evidence of candidates suffering from lack of time.

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It is expected that numerical answers will be expressed to a number of decimal places or significant figures which is appropriate to the measurements carried out by the candidate, and this was demonstrated in many good responses. The use of a 'recurring' symbol or the expression of a numerical answer in fractional rather than decimal form must be avoided.

The choice of an appropriate scale to use when constructing graphs causes difficulty for many candidates, as does the drawing of lines of best fit. This applies particularly when the range of one of the variables is limited, and a restricted scale on one of the axes would allow candidates to make better use of the allowed space on the grid.

Many candidates will have prepared for the examination (very sensibly) by working through some past papers. However, in some cases candidates gave learned answers that would have been correct in a similar question from a previous session, but were not appropriate to this question paper.

If a mistake has been made and the candidate wishes to correct the response, they should be encouraged to cross out the first answer completely and to re-write their answer clearly, rather than trying to overwrite the answer, so that there is no ambiguity. If the answer cannot be read by the Examiner, credit cannot be awarded.

Comments on Specific Questions

Question 1

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(b) Most candidates realised that a graph of *F* against *d* should be suggested. Many knew that a straight line would indicate the proportional relationship but few recalled that the line must also pass through the origin.

(c) Candidates who read the question with care realised that the weight of the spirit level would affect the forcemeter reading. They did not need to know anything about the spirit level.

(d) Most candidates sensibly drew a diagram. Some did not score because they tried to explain something unnecessarily complex and impractical. The most straightforward answers involved measuring the height of the rule from the bench at two or more intervals along its length.

Question 2

(a) Most candidates successfully recorded a realistic room temperature with the correct unit, °C.

(b) The majority of candidates recorded the times and temperatures correctly, but some gave room temperature at time 0 s and so lost credit.

(c) Candidates needed to set up the graph axes so that their plots would make best use of the grid both vertically and horizontally. A significant proportion chose a poor vertical scale, but almost all labelled the axes correctly. The plotting was usually correct. Candidates then needed to draw a line that was a good attempt at the best-fit line and not too thick. The candidates' own readings determined whether a straight line or curve was most appropriate. The Examiners gave credit according to the fit with the candidates' plots.

(d) Here candidates needed to consider carefully the aspects of good experimental technique that they had discussed and used during their IGCSE course and apply them to these specific questions. Good answers contained references to constant room temperature, constant initial water temperature and avoidance of draughts. Two suggestions were asked for in the question and candidates should be advised not to make more suggestions than the question requires as they may be penalised for contradictory suggestions.

Question 3

(a) Most candidates gave the potential difference and current values correctly. Some lost credit by not giving the current value to at least two decimal places; recorded values should reflect the precision of the measuring instrument. Most candidates went on to successfully complete the calculation.

(b) The potential difference and current values given here showed that the majority of candidates had successfully rearranged the circuit as instructed. Most candidates obtained a resistance value R_S that was close to $4R_P$.

(c) Most candidates made a correct statement but few justified it by commenting that the values were within (or beyond) the limits of experimental inaccuracy (or words to that effect). Some attempted a theoretical explanation which was not asked for and so did not gain credit.

(d) Many candidates drew the correct diagram using standard symbols. Some candidates drew resistors in place of lamps, or drew a parallel circuit in place of the series circuit required. Full credit was only awarded to those candidates who had successfully recorded the new potential difference and given the L_S value to two or three significant figures.

(e) Credit was given to those candidates who gave the potential difference, current and resistance with the correct units.

(f) Candidates were expected to know from their experience of this type of experiment, and observations made during this particular experiment, that the lamps become hot. This might be expressed by commenting on the brightness of the lamp or that it feels hot to the touch.

Question 4

(a)-(i) This question required candidates to work with care and to be familiar with drawing ray traces in this type of experiment. Most ray traces were drawn neatly and if the candidate drew the lines as instructed, then full credit was awarded. Some candidates lost credit by placing the pins too close together. Candidates need to realise that for good accuracy the pins should be placed as far apart as is practical. In this case the minimum separation to gain credit was 5.0 cm, and the most competent candidates placed their pins with a separation well in excess of 5.0 cm. A significant number of candidates drew their second set of rays on the same side of the normal as the first, not as instructed.

(j) Many candidates successfully calculated the value for refractive index and correctly gave it to two or three significant figures with no unit.

(k) Credit was awarded to those candidates who had demonstrated overall care and consistency in their work by obtaining both refractive index values in the range 1.4 to 1.6.

PHYSICS

Paper 0625/61

Alternative to Practical

Key Messages

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

The paper should be read carefully so that written answers address those specific points referred to in the questions rather than more general aspects of the same topic. Diagrams and graphs need to be drawn with care. Mathematical answers need to be expressed to an appropriate number of significant figures and with a correct unit where applicable.

General Comments

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

- graph plotting
- understanding the significance of the best-fit graph line
- determination of the gradient of a straight graph line
- drawing ray diagrams
- tabulation of readings
- manipulation of data to obtain results
- drawing conclusions
- understanding of the concept of results being equal within the limits of experimental accuracy
- dealing with possible sources of inaccuracy
- control of variables
- accurate measurements
- choice of most suitable apparatus

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

Some of the skills involved in experimental work, including graph plotting and tabulation of readings, can be practised without doing experiments. However, there are parts of this examination in which the candidates are asked to answer from their own practical experience. Explanations and justifications should refer to practical details or results rather than theory. In cases where the response involves drawing, candidates need to recognise that freehand drawing or thick lines in graphs or ray-traces will not guarantee clarity and may lead to inaccurate measurement.

It is expected that numerical answers will be expressed to a number of significant figures which is appropriate to the data given in the question or a measurement carried out by the candidate, and this was demonstrated in many good responses. The use of a ‘recurring’ symbol or the expression of a numerical answer in fractional rather than decimal form must be avoided.

Many candidates will have prepared for the examination (very sensibly) by working through some past papers. However, in some cases candidates gave learned answers that would have been correct in a similar question from a previous session, but were not appropriate to this question paper.

Comments on specific questions

Question 1

(a) A wide tolerance was given here for the value of the mass of a metre rule. Some candidates gave no unit and so did not gain credit. Others suggested masses well outside the tolerance showing a lack of awareness of the approximate masses of common objects.

(b) Most candidates successfully showed the position of the centre of mass of the cylinder. Only the better candidates could convincingly show how to place the cylinder.

(c) Candidates who had experienced this type of basic moments experiment knew that it is very difficult to achieve exact balance and expressed that clearly.

(d) Most candidates who gained credit referred to repeat readings. Reference to merely repeating the calculations did not score.

(e) Here the candidates needed to simply state that the student had not made a mistake and her result was good. This could be worded in many different ways and Examiners awarded credit if the correct idea was conveyed. The best answers showed a clear appreciation that the calculated mass agreed with the measured value to within the limits of experimental accuracy.

Question 2

(a) Most candidates successfully recorded the correct temperature.

(b) The majority of candidates correctly recorded the *d* values and gave the correct units.

(c) Many candidates correctly found the temperature difference and stated ‘higher’.

(d) Here candidates needed to consider carefully the aspects of good experimental technique that they had discussed and used during their IGCSE course and apply them to the specific question. Correct answers contained references to constant room temperature, and avoidance of draughts. Two suggestions were asked for in the question and candidates should be encouraged not to make more suggestions than the question requires as they may be penalised for contradictory suggestions.

(e) The most confident candidates were able to explain how parallax errors could be avoided by looking perpendicularly at the thermometer or metre rule scale. Other suggestions were also worthy of credit. However, many candidates did not make a suggestion that fitted the question.

Question 3

(a) A significant proportion of candidates selected a suitable scale, setting up the graph axes so that their plots would make best use of the grid both vertically and horizontally. Almost all labelled the axes correctly, and the plotting was usually correct. Candidates then needed to draw a line that was a good attempt at the best-fit line and not too thick. When determining a gradient, candidates should show clearly, on the graph, the triangle method used for the gradient. Those who gained full credit showed the triangle using at least half of the line, and obtained a value within the tolerance allowed.

(b) A number of candidates either omitted the unit Ω or gave the value to more than three significant figures, a precision greater than can be achieved from the given data and the uncertainty in determining the position of the best-fit line.

Question 4

(a) Most candidates measured *d* and *x* correctly and included the unit cm. However, some did not successfully proceed to the correct values for *D* and *X*.

(b) Most candidates performed the calculation correctly and so obtained some credit. Fewer gained full credit, for which they needed to express *f* to two or three significant figures with the unit cm.

(c) Most candidates made a correct statement and a significant proportion of those justified it by commenting that the values were within (or beyond) the limits of experimental inaccuracy, or words to that effect. To fully appreciate the meaning of questions of this type, candidates need to be discussing experimental results regularly during the course. A number of candidates responded that 'the values are different', not appreciating that differences are not significant unless they are greater than the overall uncertainties in the experiment.

(d) The most common correct answer referred to use of a darkened room. Some candidates suggested answers that were irrelevant to this question, for example constant room temperature.

Question 5

(a) Most candidates correctly showed a line of sight perpendicular to the measuring cylinder and directed towards the bottom of the meniscus.

(b)(c) Most candidates gained full credit by successfully recording the volumes with the unit cm^3.

(d) Many candidates found it difficult to focus on the requirements of the question and made suggestions involving careless technique, for example spilling water. The most confident candidates were able to study the diagrams and descriptions carefully and imagine themselves carrying out the procedure, based on personal experience. In this way they were able to make relevant suggestions.

PHYSICS

Paper 0625/62
Alternative to Practical

Key Messages

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

The paper should be read carefully so that written answers address those specific points referred to in the questions rather than more general aspects of the same topic. Drawings, such as ray-traces, diagrams and graphs, need to be carried out with care. Mathematical answers need to be expressed to an appropriate number of significant figures and with a correct unit where applicable.

General Comments

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

- graph plotting
- understanding the significance of the best-fit graph line
- determination of the gradient of a straight graph line
- drawing ray diagrams
- tabulation of readings
- manipulation of data to obtain results
- drawing conclusions
- understanding of the concept of results being equal within the limits of experimental accuracy
- dealing with possible sources of inaccuracy
- control of variables
- accurate measurements
- choice of most suitable apparatus

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

Some of the skills involved in experimental work, including graph plotting and tabulation of readings, can be practised without doing experiments. However, there are parts of this examination in which the candidates are asked to answer from their own practical experience. Explanations and justifications should refer to practical details or results rather than theory. In cases where the response involves drawing, candidates need to recognise that freehand drawing or thick lines in graphs or ray-traces will not guarantee clarity and may lead to inaccurate measurement.

It is expected that numerical answers will be expressed to a number of significant figures which is appropriate to the data given in the question or a measurement carried out by the candidate, and this was demonstrated in many good responses. The use of a ‘recurring’ symbol or the expression of a numerical answer in fractional rather than decimal form must be avoided.

Many candidates will have prepared for the examination (very sensibly) by working through some past papers. However, in some cases candidates gave learned answers that would have been correct in a similar question from a previous session, but were not appropriate to this question paper.

Comments on specific questions

Question 1

The vast majority of candidates were awarded credit in this question but the parts which addressed details of graphical and practical considerations proved to be more challenging.

(a) Most gained credit here, but the most common errors were giving incorrect units for *F* or a reversed order for the *d* values.

(b) Many candidates realised that *F* should be plotted against *d* and that the line should be straight. Fewer mentioned that the line should pass through the origin in order to indicate direct proportionality.

(c) A significant number of candidates realised that the spirit level would add an additional mass to the rule and affect the forcemeter reading. Some excellent answers referred to the additional moment which would be produced by the weight of the spirit level.

Although candidates may not have used a spirit level in practice, a careful reading of the question would have revealed it to be 'a piece of equipment' and therefore suggested its unsuitability in this case. Common incorrect responses were to state that the rule was 'not a surface' or to suggest that it would not matter if the rule was not horizontal, despite this having been given as a condition in the question.

(d) The most common correct answer indicated that equal distances measured between rule and bench at various points along the rule would show that the rule was horizontal. The better responses of this type also indicated that a set-square should be employed to ensure that the rule used to measure the distances was vertical.

A small number of candidates suggested, again correctly, that the rule could be aligned by eye with a suitable horizontal reference, such as a windowsill.

Question 2

(a) Only a very small minority of candidates were unable to record the appropriate temperature. The most common errors were reading the temperature on the thermometer as 20.3 °C rather than 23 °C, giving an incorrect unit, or omitting the unit altogether.

(b) Graphical work was often done well, particularly in terms of labelling axes correctly and plotting values. A temperature axis starting at 0 °C did not allow the plots to occupy at least half of the grid and commonly led to credit not being awarded.

Although a number of candidates produced thin, well-judged curves as indicated by the plotted points, this proved to be difficult for many and suggested that practice with this type of line would be of benefit. There were a significant number of lines which were straight or attempted to join plotted points together with short straight lines.

Some lines were too wide or were drawn to plotted points which were indicated by very large dots. Both contributed to credit being lost for what was often an otherwise perfect response. The advice is that plotted points should, preferably, be marked with a fine cross. Small dots are acceptable but are often obscured when the line is drawn through them, making it difficult to award credit for correctly plotted values. A larger circle around a small dot to indicate its position is acceptable.

(c) Most candidates correctly gave differences in room temperature or initial temperature of the hot water as conditions which might lead to variations in graphs. The question clearly stated that the experiments would be carried out with <u>identical apparatus</u> and that differences in <u>conditions</u> should be suggested. Some candidates appeared not to have read this carefully, or appreciate the implications, and this led to incorrect responses mentioning, for example, different types of beaker or thermometer.

Question 3

Many candidates, across all abilities, found aspects of this question difficult and only a few gained full credit.

(a) (i) The values of 1.9 V and 0.3 A were generally recorded correctly. Misreading of the intervals on each meter and omission of units led to loss of credit for some candidates.

(ii)(iii) Calculations were usually done correctly, with any errors from **(a)(i)** being carried forward. A number of candidates omitted the unit or gave $4R_P$ incorrectly to four significant figures rather than the expected two or three.

(b) The majority of candidates calculated the correct value for R_S. A small number read the I_2 value as 0.8 A, with the consequent error in R_S.

(c) Good responses to this part of the question were infrequent. If the answers in **(a)** and **(b)** were correct, it was expected that the statement would agree with the suggestion, the justification being that the differences between R_S and $4R_P$ were within the limits of experimental accuracy. The majority of candidates indicated, incorrectly, that any difference between the calculated values would negate the suggestion.

Where the values had been calculated wrongly and the differences were significant, disagreement with the suggestion was accepted. This mark could be gained only if the justification stated that the values were outside the limits of experimental accuracy or were too different. The response 'the values are different' was insufficient as this could also be applied to values within the limits of experimental accuracy.

There was sometimes confusion over which resistances were being referred to. The statement should have been about the two resistors used in the circuit, whereas the justification employed the calculated resistance values of Rs and $4R_P$. Some leniency was used, however, provided that the sense of the response was clear.

(d) Many candidates did not gain credit here because they showed the lamps connected in parallel, drew the voltmeter in series, or did not use the standard symbol for a lamp (a cross with a surrounding circle).

(e) While many recognised the function of a variable resistor in changing current or potential difference, few realised that, in the context of this experiment, it could be used to obtain a range of readings more easily.

Question 4

This question focused on experimental techniques and produced some good responses.

(a) Many candidates showed, correctly, a single sphere between parallel blocks with a rule overlapping the gap between the blocks. There were some careful, well-proportioned drawings but these were in the minority. Candidates should remember that lines drawn without a ruler often do not convey the intended idea and lead to loss of credit. A number of otherwise correct diagrams showed significant gaps between the rule and blocks which, in the practical situation, would lead to inaccurate measurements.

(b) (i)(ii) The vast majority of candidates scored well here, with horizontal lines of sight aligned with the bottom of the water meniscus. The subsequent V value of 70 cm^3 was generally obtained.

(iii) The calculation was most often carried out correctly and the value of 0.53 cm^3 obtained. Credit was lost for giving too many significant figures or omitting the unit.

Question 5

(a) Almost all candidates correctly drew the normal at the centre of **AB**, and there was evidence of good skills in the use of ruler and protractor. Credit was occasionally lost for not following the instructions to show **N** outside the outline of the block, i.e. above **E**, or locating **F** to the right of the normal.

A value in the range 4.2 cm to 4.4 cm was often achieved for the length, *a*, of line **NF** indicating a good standard of drawing.

(b) Accurate completion of the diagram with neat, fine lines was seen in many cases. Wider lines were less frequent here than in **Question 2** but were drawn by a significant minority. It should be recognised that accurate measurement is difficult with wider pencil lines.

Where possible, credit was given here for completion of the diagram, even with inaccurate positions of **F**, as this would already have been penalised in **(a)**. However, where **F** had been drawn to the left of the normal, it was impossible to achieve the required conditions and measurements.

Fewer candidates gained credit for the length *b* of line **FH**. The expected range of 5.9 cm to 6.5 cm depended on all aspects of the drawing having been done carefully.

While most included correct units for both *a* and *b*, a number of candidates omitted these and lost credit as a consequence.

Calculations of refractive index were good and only a minority attributed a unit or used more than three significant figures. The expected range for the value was 1.4 to 1.5.

(c) A number of good responses included ensuring the pins were well spaced, observing the bases of the pins or using fine lines for the ray-trace. Other candidates needed to be more aware of the context of this particular experiment as some answers related more to the use of light rays than pins.

While it is desirable for candidates to learn standard responses to particular types of practical question, they must be mindful of the circumstances to which these answers apply. Repeating the experiment was a common incorrect answer. This would produce greater reliability rather than greater accuracy of individual readings and it is important that candidates are aware of the distinction.

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