PHYSICS

Paper 0625/11
Multiple Choice (Core)

Question Number	Key
1	A
2	D
3	A
4	B
5	D
6	A
7	C
8	C
9	A
10	C

Question Number	Key
11	A
12	A
13	D
14	B
15	C
16	D
17	B
18	B
19	A
20	B

Question Number	Key
21	C
22	B
23	B
24	A
25	A
26	C
27	D
28	B
29	C
30	D

Question Number	Key
31	B
32	D
33	D
34	A
35	D
36	D
37	B
38	A
39	A
40	C

General comments

In some numerical questions, it was clear that some candidates had used trial and error to find a combination of the data that would produce one of the answers regardless of the logic or otherwise of such a combination.

Comments on specific questions

Question 1

Some candidates only read as far as 'average' and immediately calculated the average of the three times for 10 swings. If they had read further, they would have found 'one' emboldened, emphasising that they were expected to divide that ten-swing time by ten.

Question 2

Almost all candidates recognised that the right-hand portion of the table indicated a constant speed, but only stronger candidates knew that the increasing speed on the left-hand side indicated acceleration.

Question 3

Nearly all candidates recognised the units of mass and weight, but fewer candidates knew that the conversion factor is 10 N / kg rather than 10 N / g.

Question 5

The moment of a force is found by multiplying the force by its (perpendicular) distance from the fulcrum. Increasing either will increase the moment. Most candidates knew that you had to increase at least one, but a minority realised that you could do it by increasing either.

Question 6

If the object is moving at a constant speed there is no acceleration, and therefore no resultant force. The only diagram showing a resultant force of zero is **A**, which only the strongest candidates chose. **B** and **D**, which were the most popular choices have resultant forcers of 2 N to the right and 1 N to the right respectively.

Question 9

The most popular response was **D**, that nuclear power stations release large quantities of carbon dioxide. Nuclear power may have many disadvantages, but the overwhelming point in its favour is precisely that it doesn't release carbon dioxide.

Question 11

Weaker candidates often thought that the area of a pond affects the pressure at the bottom, whereas stronger candidates recognised that only the depth and density matter. Pascal's vases is a well-known apparatus to demonstrate this fact.

Question 14

Many candidates chose **A**, perhaps imagining that the scale divisions on a liquid-in-glass thermometer that have numbers printed by them (typically at 10°C, 20°C, 30°C, etc.) are the fixed points.

Question 17

Syllabus statement 2.3.2 is quite specific in relating convection to density changes. However, many candidates chose one of the distractors.

Question 18

When answering this kind of question, candidates should tick correct statements and to put crosses by incorrect statements. Only then, when they have dealt with the physics, should they consider the logic of the responses, deciding which response matches their pattern of ticks and crosses.

Question 20

Most candidates thought that the image lies in the plane of the mirror and only a minority recognised that it lies as far behind the mirror as the object is in front.

Question 21

Option **B** was commonly selected by the weakest candidates but was incorrect.

Question 22

The key to this question was to know the regions of the electromagnetic spectrum in order, and so to identify S as visible light. A further clue was provided by it being the only region with a very narrow range of wavelengths. A common misconception was to suppose that mobile phones use radio waves rather than the microwaves that are explicitly stated in section 3.3 of the syllabus.

Question 23

Only the strongest candidates were aware that all electromagnetic waves have the same speed in vacuo.

Question 26

The most reliable way to answer this type of question is to evaluate all three currents, writing their values next to the table, thereby dealing with the physics. Then candidates should look at the logic of the options, taking great care to work from smallest to largest (in this case) rather than the other way round.

Question 27

There was evidence of guesswork here from the weaker candidates. Syllabus section 4.2.3 is explicit about the answer.

Question 29

Stronger candidates were able to answer this correctly.

Question 30

Section 4.3.3 of the syllabus asks candidates to describe the action of a variable potential divider. However, many candidates thought that an increased p.d. across the lamp would result in less brightness or vice versa (options **B** and **C**).

Question 31

Many candidates were able to answer this correctly.

Question 32

Despite the similarity between the circuit symbols for a buzzer and a bell, many candidates made the right choice and answered correctly.

Question 33

There is a difference between preventing a short circuit and protecting against the consequences of a short circuit, so option **B** was incorrect. Fuses generally prevent too high a current in the next stretch of cable, so option **D** was the right answer.

Question 35

Candidates should be familiar with the right-hand grip rule: that if you grip a straight conductor in the right hand with the thumb indicating the direction of conventional current, then the fingers will indicate the direction of the surrounding magnetic field. Not all candidates knew this.

Question 36

Stronger candidates were successful here, while weaker candidates appeared to guess.

Question 38

Even quite strong candidates chose the lead screen, which would be pointless since the alpha particles will be absorbed by the air long before they reach it. The correct answer is to use tongs since they will prevent the hand penetrating the danger zone within 3 cm or so of the source. Keeping a good distance away from a radioactive source is always the best protection.

Question 39

Only the strongest candidates were able to deal with this graphical analysis.

PHYSICS

Paper 0625/12
Multiple Choice (Core)

Question Number	Key
1	A
2	B
3	C
4	B
5	D
6	C
7	C
8	B
9	A
10	A

Question Number	Key
11	B
12	C
13	C
14	C
15	C
16	A
17	A
18	A
19	B
20	B

Question Number	Key
21	A
22	B
23	A
24	B
25	D
26	D
27	D
28	B
29	C
30	A

Question Number	Key
31	D
32	D
33	A
34	D
35	C
36	B
37	D
38	D
39	C
40	C

General comments

In some numerical questions, it was clear that some candidates had used trial and error to find a combination of the data that would produce one of the answers regardless of the logic or otherwise of such a combination.

It was evident that energy conservation was not well understood.

Comments on specific questions

Question 2

This question relied on knowing that the distance travelled is the (scaled) area under the graph. Some candidates chose **C.** One way of approaching the question was to evaluate all the areas, and then pick the lowest. Another was to cut triangles from the areas and then reconstruct the areas as rectangles. For example, in **B**, cutting off the triangle above the 4 m / s line gives a triangle which will fit neatly upside down between the 2 s and 4 s marks, leaving a 4 m / s × 4 s square plus a triangle, which is obviously smaller than the 4 m / s × 6 s rectangle obtained by carrying out the same procedure on **A**.

Question 5

Candidates knew that that a moment is calculated by multiplying a force by a distance, so they should have been able to recognise that its unit is the unit of force multiplied by the unit of distance. Stronger candidates knew this, but weaker candidates seemed confused by the solidus in **C**, perhaps feeling that it can't be a proper unit if it doesn't include the word 'per'.

Question 6

If the velocity of a body is changing, then it has a non-zero resultant force acting on it, and vice versa. Weaker candidates appear to find this very difficult to understand. Many candidates selected option **B** but the ball is at rest, so its velocity is not changing, and it must have no resultant force acting on it.

Question 8

Most candidates recognised that, with the object speeding up as it falls, its kinetic energy must be increasing. Candidates who selected **C** presumably misread the question as being about a ball thrown upwards into the air. However, opinion was equally divided as to whether the gravitational potential energy increases or decreases. Section 1.7 of the syllabus states that energy is conserved, so if none is being supplied and the kinetic energy increases, the potential energy must decrease.

Question 10

By far the most popular choice was **D**. Candidates should have easily been able to recognise that if two quantities measured in joules are multiplied together the product will come out in J^2. However, work done is in joules, so **D** could not be right. This question was a simple application of energy conservation, this time with energy being supplied, equal to the sum of the kinetic and potential energies absorbed by the object.

Question 12

Most candidates did not read the horizontal axis but, they remembered that graphs involving gas pressure are often p-V curves indicating inverse proportion. So they selected **D** as looking most like such a curve. What is actually going on here is that as time passes, the volume decreases, so the pressure increases. It may or may not be a linear increase. The question does not provide sufficient information to decide but it is certainly an increase, and it certainly does not start from zero pressure. **C** is the only possibility.

Question 14

Weaker candidates were very unsure what was meant by a fixed point on a temperature scale as specified in section 2.2.2 of the syllabus.

Question 15

Quite a lot of candidates selected **D**, possibly imagining that the solid had been heated so much that it had melted.

Question 16

Most candidates suggested that an electromagnet produces an electromagnetic wave whereas it actually produces a magnetic field, which is not a wave. Candidates needed to ask themselves just which part of the electromagnetic spectrum each device could produce before deciding on their response. It is the electric fire that produces infra-red radiation.

Question 20

Some candidates believed that the image formed by a plane mirror is in the plane of the mirror itself rather than as far behind the mirror as the object is in front.

Question 21

A substantial number of candidates did not recognise that in ray optics, angles are measured relative to a normal to the relevant surface rather than to the plane of the surface itself. **C** was a more popular choice than **A.**

Question 24

Nearly all candidates were clear that the two signals arrive at different times, but they were equally divided about which arrives first.

Question 26

A significant proportion of candidates attempted to calculate the resistance by multiplying the current and pd. together.

Question 27

Not all candidates were able to correctly recall syllabus statement 4.2.3 that e.m.f. is measured in volts.

Question 30

Many candidates incorrectly thought that the resistance of a thermistor increases as it gets hotter. Of those who understood this, some did not know that that the p.d.'s in a potential divider behave in the same way as the resistances, so that if the thermistor's resistance is a lower proportion of the whole when hot, then the thermistor's p.d will be a lower proportion of the whole when hot.

Question 34

Weaker candidates were clearly either unfamiliar with the shape of a magnetic field surrounding a solenoid or did not know how a plotting compass can be used to indicate the direction of the field at a point.

Question 37

Nearly all candidates were clear that the number of protons needed to be one of the two numbers, but many were unsure where it needed to go.

Question 38

The most popular response was to state that background radiation originates solely in outer space, instead of from many different sources in the surroundings.

Question 40

Many candidates selected **A**, that it takes less time for three quarters of the sample to decay than it does for just half of it to decay. This was a clear case of manipulating the numbers, i.e. dividing 100 by 400 to obtain ¼, regardless of what that might imply.

PHYSICS

Paper 0625/13
Multiple Choice (Core)

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

General comments

In some numerical questions, it was clear that some candidates had used trial and error to find a combination of the data that would produce one of the answers regardless of the logic or otherwise of such a combination.

It was evident that energy conservation was not well understood.

Comments on specific questions

Question 2

The most popular, but incorrect, response was to multiply the final time by the final velocity. The correct approach was to find the scaled area under the graph. This was most easily achieved by cutting off the top right-hand triangle and inserting it into the space above the bottom left-hand triangle, thereby creating a rectangle of 10 m / s $\times$ 35 s, the scaled area of which is 350 m.

Question 3

Some candidates thought that physicists measure weight in kilograms.

Question 6

If the velocity of a body is changing, then it has a non-zero resultant force acting on it, and vice versa. Weaker candidates appeared to find this very difficult to understand. Many candidates selected option **B**.

However, the ball is at rest, so its velocity is not changing, and it must have no resultant force acting on it. Some candidates selected option **A**, in which the ball is moving with a constant velocity because of the zero resultant force acting on it.

Question 8

Most candidates recognised that, with the object speeding up as it falls, its kinetic energy must be increasing. However, those candidates who selected **C** presumably misread the question as being about a ball thrown upwards into the air. Opinion was fairly equally divided as to whether the gravitational potential energy increases or decreases. Section 1.7 of the syllabus states that energy is conserved, so if none is being supplied and the kinetic energy increases, the potential energy must decrease.

Question 9

Only stronger candidates knew that its unit is J. Many candidates wanted to measure it in N.

Question 12

Most candidates did not read the horizontal axis but remembered that graphs involving gas pressure are often p-V curves indicating inverse proportion. Therefore, they selected **D** as looking most like such a curve. What is happening here is that as time passes, the volume decreases, so the pressure increases. It may or may not be a linear increase. The question does not give sufficient information to decide but it is certainly an increase, and it certainly does not start from zero pressure. **C** is the only possibility.

Question 14

Weaker candidates are very unsure what was meant by a fixed point on a temperature scale as specified in section 2.2.2 of the syllabus.

Question 15

Syllabus statement 2.2.4 specifies that candidates should be able to state the meaning of melting point. Most candidates chose option **B**, which described the process of melting. But the melting point is the temperature at which melting occurs, and this is the same temperature as that at which solidification occurs, so **A** was the correct response.

Question 16

Most candidates suggested that an electromagnet produces an electromagnetic wave whereas it actually produces a magnetic field, which is not a wave. Candidates needed to ask themselves just which part of the electromagnetic spectrum each device could produce before deciding on their response. It is the electric fire that produces infra-red radiation.

Question 18

Syllabus statement 3.1 specifies that candidates should be able to describe how waves can undergo refraction due to a change of speed. Some stronger candidates managed this, while other candidates did not recognise that there is no change of frequency involved. Weaker candidates were unable to display any understanding of the causes of refraction.

Question 20

Many candidates believed that the image formed by a plane mirror is in the plane of the mirror itself rather than as far behind the mirror as the object is in front.

Question 30

Many candidates incorrectly thought that the resistance of a thermistor increases as it gets hotter. Of those who understood this, many did not know that that the p.d.'s in a potential divider behave in the same way as the resistances, so that if the thermistor's resistance is a lower proportion of the whole when hot, then the thermistor's p.d. will be a lower proportion of the whole when hot.

Question 31

For the lamp to be bright, the resistances of the LDR and the thermistor should be as low as possible, which involves the LDR being in bright light and the thermistor being hot.

Question 34

Many candidates were clearly either unfamiliar with the shape of a magnetic field surrounding a solenoid or did not know how a plotting compass can be used to indicate the direction of the field at a point.

Question 36

Most candidates chose **B**. If P were made of steel, it could become permanently magnetised by the magnetic field produced by the coil. It could then remain attached to the soft iron core even when the switch was open. We need both N and P to lose their temporary magnetism when the switch is open, so **A** is the correct answer.

Question 37

Most candidates knew that the number of protons needed to be one of the two numbers, but many were unsure where it ought to go.

Question 38

Alpha decay involves the emission of two protons and two neutrons from the nucleus, leaving the previously neutral atom with two more electrons than it now needs. Therefore the atom has become a negative ion. **C** is the correct response.

Question 40

Only stronger candidates answered this correctly. Many other candidates, noticing that the count rate had fallen to a quarter of its original value, just took a quarter of the 6-hour half-life as the answer.

PHYSICS

Paper 0625/21
Multiple Choice (Extended)

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

General comments

Many candidates performed well on this paper with stronger candidates answering the more challenging questions well.

Comments on specific questions

Question 5

This question proved quite challenging, with only stronger candidates being successful.

Question 7

This question, too, challenged all but the strongest candidates.

Question 9

Candidates needed to realise that if the force is applied in the direction that it is already moving, then the object will get faster and so have a higher kinetic energy. They needed to remember that work done and kinetic energy are both measured in joules and may be added.

Question 11

Some candidates did not use *g*, while others did not subtract the two heights.

Question 14

The sensitivity of a liquid-in-glass thermometer is a measure of how far the thread moves along the capillary tube for a given change of temperature irrespective of how long it takes to do so. Many candidates thought that sensitivity was a question of rapidity of response.

Question 17

Only stronger candidates answered this correctly. Other candidates did not notice that the 3000 crests passed by in a minute rather than in a second.

Question 20

Many candidates thought that the image lies in the plane of the mirror and only a minority recognised that it lies as far behind the mirror as the object is in front.

Question 29

Many candidates calculated the power rather than the energy delivered.

Question 30

The most popular choice was **A**, indicating that candidates thought that the diode has no effect whatever. However, stronger candidates were successful in choosing option **C**.

Question 32

Despite the similarity between the circuit symbols for a buzzer and a bell, many candidates made the right choice here and answered correctly.

Question 33

Weaker candidates found this question about logic gates challenging. The only way the final OR can have an output of 0 is if both of its inputs are 0, which in turn means that both X and Y need to be 1. This is the function performed by a NAND gate, i.e. option **D**

Question 37

Weaker candidates were very unsure about Rutherford’s scattering experiment, or the deductions made from it.

PHYSICS

Paper 0625/22
Multiple Choice (Extended)

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

General comments

Broadly speaking, most candidates produced scores in the range 15–37, with just a few outliers. The highest score was 39. The more searching questions were tackled most successfully by the most able candidates.

Comments on specific questions

Question 5

A body in equilibrium has a zero moment, no matter what point is chosen as the fulcrum. This fact was only appreciated by about half of the candidates.

Question 10

The second most popular choice was **D**. Candidates should easily be able to appreciate that if two quantities measured in joules are multiplied together the product will come out in J^2. Yet work done is in joules, so **D** cannot possibly be right. This question is in fact a simple application of energy conservation, with energy being supplied, equal to the sum of the kinetic and potential energies absorbed by the object.

Question 12

Many of the weaker candidates failed to read the horizontal axis, went into autopilot mode and remembered that graphs involving gas pressure are often *p*-*V* curves indicating inverse proportion. So they selected **D** as looking most like such a curve. What is actually going on here is that as time goes on, the volume decreases, so the pressure increases. It may or may not be a linear increase – we are given insufficient information to decide – but it is certainly an increase, and it certainly doesn't start from zero pressure. **C** is the only possibility.

Question 14

Many candidates do not appear to appreciate that a sensitive liquid-in-glass thermometer is one that gives a large movement of the position of the liquid regardless of how long that takes or how much thermal energy is required to achieve it. Option **C** is wrong because a small volume of liquid in the bulb will only be able to produce a small extra volume of liquid in the capillary tube when heated.

Question 15

Most candidates knew how to go about this calculation, but some forgot to subtract the final mass from the initial mass to discover how much had evaporated, while others correctly converted the mass to kg for the calculation, but then forgot that they had done so when selecting a response.

Question 16

Most candidates suggested that an electromagnet produces an electromagnetic wave whereas it actually produces a magnetic field, which is not a wave. Candidates needed to ask themselves just which part of the electromagnetic spectrum each device could produce before deciding on their response. It is, in fact, the electric fire that produces infra-red radiation. (It would be possible to argue that the generator and motor produce radio 'interference', but that is accidental and not part of the design.)

Question 17

Candidates are expected to know that sound travels more quickly in water than in air, so that, given the constant frequency, the wavelength must increase. Only the top third were able to deal with this.

Question 19

Over a third of the candidates took the angle of incidence as 40° instead of using that value to calculate the angle of incidence relative to the normal. The very best candidates were successful.

Question 22

The weaker candidates are clearly not familiar with this depiction of a sound wave, while the stronger candidates are.

Question 24

Nearly all candidates were clear that the two signals arrive at different times, but they were equally divided about which arrives first.

PHYSICS

Paper 0625/23
Multiple Choice (Extended)

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

General comments

Many candidates performed well on this paper with stronger candidates answering the more challenging questions well.

Comments on specific questions

Question 5

Each string exerts an upward force of 1.0 N (candidates selecting **A** probably forgot to multiply by *g*). The standard way to proceed is to take moments about O, thereby avoiding the need to know what the force the pivot is exerting on the rod, and candidates who solved this problem may well have done this. However, some of these candidates might have overlooked the potential force from the pivot entirely and simply added the two string forces together. That this works can be seen by taking moments about the centre of the rod, when it is easy to see that the two strings give balancing moments without needing any contribution from O.

Question 6

Stronger candidates chose **A** but some other candidates chose **B** or **C**.

Question 7

Some candidates chose **A**, when at this level they might be expected to see that the (time $\times$ a speed) is a distance, which (force $\times$ mass) certainly is not.

Question 9

Many candidates did not realise that this question was a straightforward application of the mechanical work done equation. A number of distances and force values were given and the candidate needed to use the appropriate values to obtain the correct answer.

Question 12

Many weaker candidates did not read the horizontal axis but remembered that graphs involving gas pressure are often p-V curves indicating inverse proportion. Therefore, they selected **D** as looking most like such a curve. What is actually going on here is that as time passes, the volume decreases, so the pressure increases. It may or may not be a linear increase. The question does not give sufficient information to decide but it is certainly an increase, and it certainly doesn't start from zero pressure. **C** is the only possibility.

Question 14

Many candidates did not appear to realise that a sensitive liquid-in-glass thermometer is one that gives a large movement of the position of the liquid regardless of how long that takes or how much thermal energy is required to achieve it. Option **C** is incorrect because a small volume of liquid in the bulb will only be able to produce a small extra volume of liquid in the capillary tube when heated.

Question 16

Most candidates suggested that an electromagnet produces an electromagnetic wave whereas it actually produces a magnetic field, which is not a wave. Candidates needed to ask themselves just which part of the electromagnetic spectrum each device could produce before deciding on their response. It is the electric fire that produces infra-red radiation.

Question 25

Some candidates thought that a magnet can be demagnetised by passing a direct current through it. The only method which comes close to this is to withdraw the magnet slowly from inside a solenoid in which there is an a.c. as this process takes the material round a sequence of ever-diminishing hysteresis loops

Question 30

Most candidates correctly identified the circuit symbol for an LDR, but not all of them could work out that increasing the light intensity decreases the LDR's resistance, so that the LDR has a lower proportion of the total resistance and therefore a lower proportion of the total p.d. across it.

Question 34

Weaker candidates were clearly either unfamiliar with the shape of a magnetic field surrounding a solenoid or did not know how a plotting compass can be used to indicate the direction of the field at a point.

Question 36

Only stronger candidates were familiar with the Right-Hand Dynamo Rule.

Question 37

Weaker candidates were very unsure about Rutherford's scattering experiment or the deductions made from it.

Question 40

Some candidates negotiated this question successfully. However, many others realised that they were dealing with two half-lives and therefore looked for a count rate that was a quarter of its original value, but they failed to correct the readings for the background count rate.

PHYSICS

Paper 0625/31
Theory (Core)

Key messages

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

- In calculations, candidates must set out and explain their working correctly. When candidates give an incorrect final answer and no working is shown, it is often impossible for partial credit to be awarded for any correct working.
- Greater clarity and precision is required when answering questions requiring a description or explanation.
- It is important that candidates read the questions carefully in order to understand exactly what is being asked.
- In order to improve their performance, candidates should practise applying their knowledge to new situations by attempting questions in support materials or exam papers from previous sessions.

General comments

Many candidates were well prepared for this paper. Equations were generally well known by stronger candidates, but a significant number of other candidates struggled to even recall the equations.

Often candidates knew how to apply their knowledge and understanding to fairly standard situations. On occasions, when asked to apply their knowledge to a new situation, they became confused and displayed a lack of breadth of understanding. Weaker candidates had difficulty in applying their knowledge to new situations, did not show the stages in their working and did not think through their answers before writing.

Many calculations were well set out but there were some candidates who were not clear. Another problem that a minority had was in transposing equations. They regularly started with a correct formula but could not always translate this into correct use of the data in the question.

The questions on levers, advantages and disadvantages of using natural gas as an energy source and explaining the action of a potentiometer in a circuit were generally not well answered. Many candidates either did not read the questions carefully or gave answers that were related to the topic being tested but, did not answer the question in enough detail to receive credit.

The English language ability of the majority of the candidates was adequate for the demands of this paper. There were a very small number of candidates who struggled to express themselves adequately.

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

Comments on specific questions

Question 1

(a) Most candidates gave the correct answer of 21 cm^3.

(b) This calculation was done well by many candidates who gave the correct answer of 0.2 cm^3. With error carried forward from the previous question many candidates gained full credit. Weaker candidates did not read the question carefully and divided 25 cm^3 by 20.

(c) Responses to this question were generally good. Some weaker candidates just stated "take the reading on the measuring cylinder" when they needed to say that they were measuring a volume.

Question 2

(a) Almost all candidates gained full credit on this question. Weaker candidates added the two forces instead of subtracting. A small number gave the direction as East with no indication on the diagram of what was meant by East.

(b) (i) Many candidates simply wrote a copy of the stopwatch screen. Centres should encourage candidates to use stopwatches in practical exercises, such as determining the speed of sound, and to practise changing the display reading into a time in seconds.

(ii) This calculation was answered well by most candidates. A small number started with the correct equation of speed = distance ÷ time but managed to rearrange this so that they divided 12.8 by 200 rather than 200 ÷ 12.8.

(c) Only stronger candidates gained full credit for this question. Candidates should be encouraged to practise calculating the area below speed-time graphs when the area is a trapezium shape.

Question 3

(a) The vast majority of candidates gained full credit. The most common error was starting with an incorrect arrangement of the equation. This was usually moment = force ÷ distance.

(b) (i) Only stronger candidates answered this fully correctly. Candidates should be encouraged to practice writing energy transfer equations for common situations or appliances.

(ii) This item was slightly better answered than **(i)** but many candidates displayed a lack of understanding of useful and non-useful energy transfers.

Question 4

(a) The majority of candidates calculated the weight in newtons correctly, but a significant divided by 10 or multiplied by 1000.

(b) Only stronger candidates answered this correctly. Most candidates did not realise that the work done on the mass was equal to its increase in gravitational potential energy.

(c) This calculation was done well by the majority of candidates who evaluated P = F/A to give the correct answer. Only a few candidates used an incorrect rearrangement of the equation. Many candidates gave the correct unit but a significant number gave the unit as Pascals (Pa).

Question 5

(a) (i) The majority of candidates correctly calculated the difference in height between the two levels of mercury in the manometer. However, many did not know what to do with this value of 120 mm of Hg. Common errors included 760 ÷ 120, 760 × 120 and 760 – 120.

(ii) There were many candidates who correctly identified the mercury manometer. Common errors included barometer and thermometer.

(b) (i) Many candidates did not give a simple kinetic theory model of how a gas exerts a pressure on a surface. Few candidates mentioned molecules in air moving at high speed or molecules colliding with the cylinder.

(ii) Many candidates recognised that the pressure decreased but far fewer went on to link this with the reduced rate of collisions with cylinder wall or even with fewer collisions with cylinder wall.

Question 6

(a) (i) Many candidates recognised the effect as refraction but almost as many stated diffraction or even reflection. Centres should encourage candidates to watch demonstrations, possibly on the internet, of the use of ripple tanks to display reflection, refraction and diffraction effects.

(ii) There were many answers deserving full credit that showed a good grasp of the relevant science.

(b) Many candidates answered fully and correctly.

(c) (i) Most candidates gave a correct example of a transverse wave. Weaker candidates gave a longitudinal wave.

(ii) There were many answers that gained full credit and showed a good grasp of the relevant science. Weaker candidates tended to talk about particles moving up and down or side to side.

Question 7

(a) Many candidates recognised that the bar was a magnetic material that was magnetised (or a magnet) which they knew because the same end of the metal bar was attracted by the N pole and repelled by the S pole.

(b) Only stronger candidates gave a clear description of a sensible method for plotting the magnetic field, giving sufficient detail for someone to be able to follow. However, there were many candidates whose knowledge of magnetism was limited to roughly what the field around a magnet looks like and the laws of attraction and repulsion, and no further.

Question 8

(a) Most candidates answered this well. This topic was well understood by the majority of candidates, but many would have benefited from even more practice to avoid drawing lines through symbols. The most common mistake was an incorrect battery symbol.

(b) The majority of candidates gave a correct answer, but a significant number chose protons instead of electrons or just put “charges”.

(c) This calculation was done well by most candidates, with the vast majority of these arriving at a correct solution of 6.0 V. Some candidates started with the correct equation of $V = I \times R$ but rearranged this so that they divided 15 by 0.4. A more common error was to start with an incorrect arrangement of the equation, usually $V = I \div R$. Centres should recommend to candidates that they commit to memory all the equations in the specification.

Question 9

(a) (i) Many candidates recognised that the fuse protects the transformer or wiring from fire or overheating but answers from weaker candidates were often too vague to gain credit.

(ii) Many candidates gave a good description of how a fuse works. However, weaker candidates tended to talk about electricity or power rather than the electric current in the fuse.

(b) The transformer calculation was very well answered by many candidates. The most common error was an incorrect equation as the starting point. Candidates who started with the correct equation sometimes made errors in rearranging the equation.

(c) (i) Many candidates correctly gave iron as a suitable material for the transformer core. Weaker candidates thought the core was made from wood.

(ii) Many candidates correctly gave copper as a suitable material for the coils of a transformer. A common mistake was to have the answers for **(i)** and **(ii)** transposed.

(iii) Many candidates answered this correctly and displayed a good understanding of step-down transformers. Weaker candidates merely stated that it was something to do with the coils.

Question 10

(a) There were many candidates who were awarded partial credit, but only stronger candidates were awarded full credit. Weaker candidates showed a lack of knowledge on this part of the specification.

(b) The vast majority of candidates gained partial credit here, but stronger candidates answered fully correctly. Common errors included 147 for the nucleon and having the nucleon and proton numbers transposed.

(c) Many candidates found this question challenging. The topic of half-life was not well understood by many candidates. Very few candidates attempted to determine the number of half-lives that had passed in 28 years. Those that correctly stated that 28 years was equivalent to 2 half-lives then did not know how to use this information. The most common approach was to divide the number of atoms by 2.

PHYSICS

Paper 0625/32
Theory (Core)

Key messages

Candidates should note both the number of marks available and the space allocated for responses, as these factors provide a clear indication of the type of answer expected. For example, for a two-mark question, two distinct points should be given.

In calculations, candidates should set out and explain their working clearly. Credit may be given for correct working even if the final answer is incorrect.

Before starting their response, candidates are advised to read the question carefully, paying attention to the command words, to ensure they focus their answers as required.

General comments

Some areas of the syllabus were better known than others. In particular, the measurement of temperature, thermal processes and magnetism were not well understood.

Equations were generally well known by all but the weakest candidates. Many candidates understood how to apply equations to fairly standard situations well.

For many candidates, the non-numerical questions were more of a challenge than the numerical questions.

Several candidates struggled to express themselves adequately when answering the extended writing questions.

Comments on specific questions

Question 1

(a) (i) Most candidates realised that the speed of the skydiver was increasing or that she was accelerating. Answers such as, just "increasing or the motion was increasing" were too vague to credit.

(ii) Most candidates gave the correct answer.

(iii) A large number of candidates gave the correct answer. Some confusion interpreting the graph was seen when **B** or **D** was given as the answer.

(iv) Most candidates understood that the area under a speed–time graph determines the distance travelled. One error was determining the area of the wrong section of the graph. Another error was applying the equation, speed = total distance / total time. These answers gained credit for recall of the equation.

(b) (i) Many candidates realised that the varying upward force was air resistance or a type of resistive force. Common incorrect answers were resultant force, weight or gravity.

(ii) This question was answered very well.

(iii) Candidates generally lacked the knowledge that an object continues in a straight line at constant speed unless acted on by a resultant force.

(c) Many candidates answered this question well with most showing full working. Some confusion between mass and weight was evident.

Question 2

(a) (i) There were a wide variety of answers naming parts of the device e.g. ruler, U-tube, rather than stating the name of the whole device. There was some confusion between a barometer and a manometer.

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

(b) Candidates needed to understand that the manometer indicated the excess pressure above atmospheric pressure. Common incorrect answers were 160 mm and 4.75 mm (being 760 / 160). There were a noticeable number of no responses.

(c) Candidates needed to apply their knowledge to compare the densities of mercury and water. Many answers focussed on the visibility of clear water, but the question was concerned with coloured water.

(d) Most of candidates gave the correct answer.

Question 3

Only stronger candidates had the required knowledge for all parts of this question.

(a) (i) A few candidates gained credit by recognising that the thermometer needed to be placed in steam above pure boiling water.

(ii) Many candidates realised that ice needed to be used. However, the ice needed to be melting (or in a mixture with pure water).

(iii) A number of candidates explained, in their own words, that the fixed points were needed to calibrate the thermometer. Most of these answers gained credit.

(b) (i),(ii) Very few correct answers were seen. Candidates did not seem to know the meaning of the term physical property. There were a substantial number of blank answers.

Question 4

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

(ii) There was a wide variety of answers but only the strongest candidates gained full credit. Most candidates correctly stated that the liquid molecules became gas or vapour molecules. Several candidates focused their answers on the cooling effect of evaporation, but this was not required here.

(b) Many candidates understood that a lid and/or wrapping the container with (insulating) material or silver foil would reduce the transfer of thermal energy. A significant number were aware that a surrounding the container with a vacuum would also be successful. Several candidates suggested using a metal container, but this gained no credit.

Candidates did not seem to know the meaning of the term thermal transfer process. It was quite common to see a phrase such as just “heat energy”, “it reflects heat” or “it absorbs heat” instead of quoting one of the processes of thermal energy transfer.

Question 5

(a) (i) Many correct answers were seen but a significant number of candidates gave the incorrect letter P.

(ii) The majority of candidates were correct.

(b) Several candidates gave the correct answer. A noticeable number of candidates either gave no response or thought the wave was longitudinal.

(c) A common error was to state the number of cycles or waves in a given or specific time. The number of cycles or waves per second or unit time was the correct answer.

(d) (i) Many correct answers were seen here.

(ii) Candidates generally lacked the knowledge for this question.

(e) (i) The majority of candidates were correct. There was a tendency to choose ultraviolet rays, which gained no credit.

(ii) The answer 'radio waves' was the most common answer given but the correct answer was microwaves.

Question 6

(a) (i) Most candidates gained credit for naming the normal.

(ii) Many candidates gave no response. Some of those that did answer identified the angle correctly but others labelled the reflected ray.

(iii) Often answers lacked precision. Answers such as "the incident ray is equal to the reflected ray" were too vague for credit.

(b) Most candidates correctly circled "the same size" but often this was the only answer circled. There were two marks for the question, indicating that two answers were needed for full credit. When, for example, "same size" and "diminished" were circled, this was a contradiction and so gained no credit.

(c) (i) Most candidates had the correct general idea with stronger candidates gaining full credit. Other candidates confused the prism with the action of a parallel sided block and drew the emergent ray parallel to the incident ray. Candidates need to be aware that a ray of red light will not disperse.

(ii) Only the strongest candidates realised that the ray was refracted at both boundaries.
Many explanations incorrectly referred to reflection or dispersion. A noticeable number of candidates gave no response.

Question 7

Candidates generally lacked the knowledge for most parts of this question. There were a substantial number of no responses.

(a) (i) Candidates generally did not recall the name electromagnet.

(ii) Few correct answers were seen.

(iii) Many correct answers were seen here but a common error was "use a stronger magnet".

(iv) Answers tended to be too vague to gain credit. For example, the answer, "a crane", needed to be developed into "a crane for picking up cars in a scrap yard" which would have gained credit.

(b) (i) An understanding that steel would become a permanent magnet was required for this question.

(ii) Candidates needed to be aware that copper is not a magnetic material.

Question 8

(a) The majority of candidates answered this question well. A common error was placing the voltmeter in series with the ammeter. There were a noticeable number of no responses.

(b) The majority of candidates gained credit for the correct numerical answer, writing the equation and showing full working. There were several incorrect answers based on an incorrect equation.

Question 9

(a) Candidates generally lacked the knowledge for this part and there were a significant number of no responses. A common mistake was "alternative current".

(b) Again a general lack of knowledge was evident and there were a substantial number of no responses.

(c) Many correct answers were seen here. There was some confusion between the magnetic properties of iron and steel.

(d) Most candidates answered this question well. Weaker candidates mainly gained credit for recalling the equation.

(e) Very few correct answers were seen. Candidates did not seem to recognise that a transformer only works with an alternating current.

Question 10

(a) (i) Several candidates gained at least partial credit and a significant number gained full credit. A common error was to use "bigger" magnets instead of "stronger" or "more powerful" magnets.

(ii) Many correct answers were seen. Other answers tended to be too vague to gain credit, for example, "move the magnet".

(b) Most candidates gained some credit here. The most common error was magnetic fields with opposing directions on lines of force.

Question 11

(a) (i) Most candidates answered this question well.

(ii) There was some confusion between the ionising properties of alpha and beta particles.

(iii) There was some confusion between the charge on alpha and beta particles.

(b) Very few correct answers were seen. Candidates did not seem to recognise that beta particles are (high-speed) electrons.

(c) A few candidates gained partial credit for understanding that the age of the spoon was equivalent to three half-lives. A noticeable number achieves full credit.

PHYSICS

Paper 0625/33
Theory (Core)

Key messages

Candidates should note both the number of marks available, and the space allocated for responses, as these factors provide a clear indication of the type of answer expected. For example, for a two-mark question, two distinct points should be given.

In calculations, candidates should set out and explain their working clearly. Credit may be given for correct working even if the final answer is incorrect.

Before starting their response, candidates are advised to read the question carefully, paying attention to the command words, to ensure they focus their answers as required.

General comments

Some areas of the syllabus were better known than others. Total internal reflection, ray diagrams, the action of a converging lens, electric circuits and radioactivity were not well understood.

Equations were generally well known by all but the weakest candidates. Many candidates understood how to apply equations to fairly standard situations well.

For many candidates, the non-numerical questions were more of a challenge than the numerical questions.

A noticeable number of candidates struggled to express themselves adequately when answering the extended writing questions.

Comments on specific questions

Question 1

(a) (i) The majority of candidates gave the correct answer.

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

(iii) Most candidates gained credit for stating that the greatest deceleration occurred as the tram approached C. However, the reason was often too vague to credit. For example, "the tram needed to slow down from the greatest speed". Additional detail concerning the time taken was required. The greatest slope was the most concise reason.

(b) The vast majority of candidates gained full credit, most writing the equation and showing full working.

Question 2

(a) (i) The majority of candidates gave the correct answer.

(ii) The recall of how to obtain an average value for a small length by measuring multiples was varied. Many candidates gave a full detailed answer. Others just measured the thickness of one tile repeating the measurement several times and finding the average value.

(b) (i) Many correct answers were seen.

(ii) Many candidates gained full credit for the correct numerical answer and unit, usually writing the equation, and showing full working. There were several incorrect answers based on an incorrect equation.

(iii) Many correct answers were seen but a common error was not converting the mass in g to kg. There were a noticeable number of no responses.

Question 3

(a) Many candidates gained some credit here. A common misconception was that wind is the input energy for a wind turbine instead of kinetic.

(b) (i)(ii) Again most candidates gained some credit here. There was a general lack of understanding that the initial energy was chemical.

Question 4

(a) (i) The majority of candidates gave the correct answer.

(ii) Some confusion between boiling and evaporation was seen here.

(b) Most candidates gained some credit here. There was some lack of understanding that the melting and boiling temperatures would remain the same.

(c) The majority of candidates gained full credit by displaying a good knowledge of the molecular model.

Question 5

(a) (i) Few correct answers were seen, and most candidates drew a refracted ray in the prism. The conditions for total internal reflection did not seem to be fully understood.

(ii) Some correct answers were seen but the drawn normal line often tended to be parallel to the boundary or at right angles to the drawn ray. There were a noticeable number of no responses.

(iii) Very few correct answers were seen. The conditions for total internal reflection did not seem to be fully understood.

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

(ii) Some confusion *between wavelength, frequency, and speed* was seen here. There were a significant number of no responses.

Question 6

Candidates generally lacked the knowledge for most parts of this question. There were a substantial number of no responses.

(a) There were a wide variety of incorrect answers, usually light related; incidence, refraction and normal were common.

(b) Some candidates gained credit for a paraxial ray from the object to the lens.

(c) There was a tendency for candidates to label the point where their rays crossed rather than drawing the full image, which was required.

(d) Many candidates answered this correctly. When, for example, “same size” and “diminished” were circled, this was a contradiction and so gained no credit.

Question 7

(a) (i) Many correct answers were seen here.

(ii) Several candidates gained at least partial credit with a significant number achieving full credit. A common error was indicating that the amplitude would not change.

(b) (i) Many correct answers were seen here.

(ii) The majority of candidates gained full credit, writing the equation and showing full working. There were several incorrect answers caused by not doubling the distance.

Question 8

(a) Most candidates gained at least partial credit with a significant number achieving full credit. A common error was to state that a mobile phone used radio waves.

(b) Many candidates gained at least partial credit with many gaining full credit. A common error was to name regions of the electromagnetic spectrum instead of their properties. There were some no responses.

(c) Answers tended to be too vague to gain credit, for example, "wear protective clothing", "wearing an apron". The most common correct answer was the idea of remote working.

Question 9

(a) (i)(ii) All candidates attempted these parts with most gaining at least partial credit. A significant number achieved full credit in both sections.

(b) (i)(ii) A general lack of knowledge of the electrical symbols for an *a.c. supply* and a *fuse* was evident and there were a considerable number of no responses.

(iii) Candidates tended to say that the fuse *controlled the current* rather than the *fuse prevented excess current.* There were a noticeable number of no responses.

(iv) Very few candidates appreciated that a circuit breaker had the ability to be reset or reused, so correct answers were seldom seen. There were a noticeable number of no responses.

(c) Many correct answers were seen.

Question 10

There were a substantial number of no responses to this question.

(a) (i) Most candidates answered this question well.

(ii) There was some confusion between the ionising properties of alpha and beta particles.

(iii) There was some confusion between the charge on an alpha and a beta particle.

(b) (i),(ii) Most candidates answered this question well.

(c) Several candidates gained partial credit for recognising that 24 days was equivalent to three half-lives. Stronger candidates gained full credit.

PHYSICS

Paper 0625/41
Theory (Extended)

Key messages

Many numerical answers were given with either an incorrect unit or without a unit being supplied. Most of the measurable quantities in the subject content that need to be understood require an SI unit.

Candidates need to be able to rearrange equations and to conduct calculations correctly. Subtracting a negative number or dividing by a number in standard form with a negative exponent was problematic for some candidates.

In discursive questions, candidates need to ensure that the comments made are relevant, are accurate and do not contradict what has already been stated either in the answer or in the question itself.

Although some questions use terms that are directly related to the appropriate leaning object in the syllabus, there are always questions set in an unusual context and where the appropriate approach is not stated as explicitly in the wording.

General comments

There were some strong responses this session and many candidates answered well. Occasionally candidate responses were not clearly written. Candidates should be reminded to ensure their responses are legible and clearly set out in the appropriate place on the question paper.

Comments on specific questions

Question 1

(a) This was quite often answered well, and many candidates were awarded full credit here.

(b) (i) Many candidates gave the correct final answer and gained credit for it. Sometimes the correct numerical answer did not include an appropriate unit. The unit kg m / s was acceptable but occasionally, this was given as kg / m / s which was incorrect.

(ii) Some candidates stated that it was block B that was being discussed and, in many cases, what was described applied to neither block. Many candidates stated that the kinetic energy of block A decreased but a common error was to add that it was transferred to gravitational potential energy. Friction was rarely referred to in the explanation.

Question 2

(a) (i)(ii) Both of these two parts were very well answered and full credit was awarded very frequently. Sometimes candidates suggested force as one of the two other vectors. That force is a vector is given in the initial text and candidates needed to keep in mind the context of the question.

(b) (i) This part was well answered and the correct numerical value was very frequently supplied. This was not always followed by a unit.

(ii) Many candidates referred to or described the elastic limit. This was close to but not the same as the limit of proportionality. There were many correct values for the appropriate weight but 12.0 N was also commonly seen.

(iii) Although some candidates worked their way through to a correct final answer, others made errors and did not gain full credit. A common approach was to identify a point on the line of the graph and to divide a weight by the corresponding length of the spring rather than the corresponding extension of the spring.

Question 3

(a) This was very often correct, but some candidates incorrectly gave 62 kg 620 J or another incorrect answer.

(b) Many candidates were able to give at least one appropriate condition for equilibrium, but fewer gave two. Some incorrect answers referred to the centre of gravity being with the base area or made reference to some property of the climber.

(c) (i) This calculation was often correct, but some candidates used an incorrect distance or unit.

(ii) Many candidates found this question challenging and some made no attempt at it. Candidates who attempted to balance the moments often made some progress but only the strongest candidates supplied a correct final answer.

Question 4

(a) (i) This was often answered well with candidates giving a correct numerical value. A small number of candidates rearranged the expression $p = F / A$ incorrectly and obtained $F = p / A$. This did not lead to the correct value.

(ii) This part was also answered well, and the correct final answer was often seen. A common error was the use of 0.21 m rather than 0.021 m and some candidates divided the force from **(i)** by the distance. It is not obvious what misunderstanding led to this error.

(b) The calculation here was quite often correct. Where the final answer was incorrect, this was sometimes due to the use of a temperature difference of 3.0°C or because of an attempt to apply $E = mc\Delta T$.

(c) This part was not well understood but many candidates were able to make a correct reference to the reduced speed or kinetic energy of the molecules or to indicate that the pressure was the result of molecular collisions with the interior surface of the cylinder. The cancellation of the effects of the reduced speed and of the increased collision frequency was rarely seen.

(d) Candidates often referred to the greater distances between the molecules of a gas or to the greater intermolecular forces acting in a solid, but few candidates made both points and were awarded full credit.

Question 5

(a) Many candidates supplied the answer of microwaves rather than infrared radiation, and other components of the electromagnetic spectrum were also seen in responses. There were also candidates who used other terms such as convection or radioactivity.

(b) (i) Candidates who realised that the two waves were electromagnetic were often able to supply a similarity.

(ii) Although answers such as different frequencies were accepted, an incorrect relationship was not and this part was less well answered than the previous part.

(c) (i)(ii) These two parts were only answered well by stronger candidates and many others merely repeated the question. A significant number of candidates did not describe an experiment at all and of those who did, an experiment that compared the absorption properties of differently coloured surfaces was more often given than what was asked for. Some candidates were not sure what the terms experiment and equally mean. Some candidates used a phrase such as “good absorbers and good emitters” without distinguishing between emission and absorption.

Question 6

(a) Most candidates answered this correctly. A common incorrect answer was “light of a single colour” and was not credited.

(b) (i) Few candidates explained why the light does not change direction. References to the angle of incidence and to the angle of refraction were rare and more often candidates tried to offer explanation in terms of total internal reflection.

(ii) A number of candidates who were able to determine the refractive index were also able to reach the correct final answer. Other candidates were sometimes able to gain partial credit for a correct equation or expression.

(iii) Few candidates deduced that the critical angle for the blue light is less than that for the red light and that because the angle of incidence has not changed, the angle of incidence is now greater than the critical angle. Answers in terms of refraction out of the block were common.

Question 7

(a) Only a minority of candidates were able to explain the attraction and contact of the springy strips completely, but partial credit was often awarded for comments that were relevant.

(b) (i) Many candidates were able to calculate the final answer correctly and were awarded full credit. A common error was not converting kilowatts to watts and so answers were a thousand times too small.

(ii) Many candidates stated that the use of wires with a large cross-sectional area resulted in a small resistance. However, the fact that this reduction decreases the energy transferred to thermal energy in the wires was not so often referred to. Many candidates merely stated that the reduced resistance would result in a larger current.

(c) Few candidates were able to complete the circuit diagram, but many gained partial credit for connecting the motor in a circuit that contained the relay switch.

Question 8

(a) Many candidates repeated what was given in the question and stated that both electromotive force (e.m.f.) and potential difference (p.d.) are measured in volts. Only the strongest candidates answered correctly.

(b) This was answered more successfully, with most candidates gaining credit for referring to an e.m.f. being the property of a power source.

(c) (i) This part was very often correct. There was no obvious pattern to answers which did not gain credit.

(ii) Although the correct final answer was seen regularly, candidates who did not gain full credit were often uncertain as to which resistors were in series and which were in a parallel. Some candidates placed all four in series or all four in parallel and other incorrect combinations were suggested by the calculations carried out.

(iii) Candidates who gained full credit realised that the answer could be obtained by treating the arrangement as a potential divider. Those who calculated the current were less likely to reach the final answer.

Question 9

(a) Few candidates were awarded credit for this part. Many candidates contradicted the content of the question and stated that different atoms of naturally occurring gold contain different numbers of neutrons.

(b) (i) Some candidates gave answers that suggested that the nuclide notation for a beta–particle is ${}^{0}_{1}b$. This is probably because of an incorrect subtraction of –1 during the calculation.

(ii) Most candidates gave the correct answer here but others supplied a count rate from another part of the graph. Of these, the value 390 counts / min was the most frequently given.

(iii) Many candidates approached this in the correct way but fewer of these obtained an acceptable value for the half-life. Some candidates did not subtract the background count before halving the value read from the graph and out of those that did, many did not add it back on to the value obtained before using the graph.

PHYSICS

Paper 0625/42
Theory (Extended)

Key messages

Candidates should read questions carefully ensuring that they are answering exactly the question that is asked.

Candidates should always write down formulae before substituting values into equations. This will give them access to partial credit even if they make incorrect substitutions, or transcription errors, or rearrange equations incorrectly.

It is important to use correct symbols for quantities. (The syllabus lists the usual symbols for all the quantities candidates are expected to know.) Candidates should be taught to use t for time, T for temperature and E for energy, (Q is not accepted for energy, t is not accepted for temperature and T is not accepted for time).

For questions involving multi-stage calculations, candidates should be taught not to round values until the final answer. Rounding of a value part-way through a calculation can lead to an incorrect numerical value for the final answer.

Noting how many marks each question is worth can help guide candidates as to the level of detail required in an explanation. Candidates should avoid repeating phrases from the question in answers that ask for an explanation. Instead, they should be encouraged to apply their physics knowledge to the situation described in the question.

Candidates should also be made aware that from 2023 all calculations involving g must use the weight of 1.0 kg as 9.8N (acceleration of free fall = 9.8 m/s^2).

General comments

Candidates demonstrated a strong understanding of the physics covered in this syllabus with many good answers seen across the whole range of topic areas. Diagrams were often drawn carefully, using sharp pencils and neat straight lines drawn with a ruler. There were very few numerical answers given without a unit on this paper. The omission of a unit was most often seen in **Question 1(c)** and **Question 10(c)**.

Comments on specific questions

Question 1

(a) Many candidates gained full credit combining ρ = m/V and V = l × w × d correctly to find the value of d. A common error was giving the answer to only 2 significant figures. A few candidates incorrectly rounded their answer by truncating their value of d to 0.210 m. Candidates who chose to use P = F/A and P = hρg usually did not end up with the correct numerical answer as they forgot to use $F = mg$, which was also necessary with that method. The weakest candidates were unable to make a start with this question

(b) To calculate the decrease in gravitational potential energy per second, candidates needed to convert kg/minute into kg/s and then use this value for mass in the formula GPE = mgh. While almost all candidates recalled the correct formula only the strongest candidates were able to convert the mass and calculate the correct numerical value. A few candidates mistakenly thought that they should use their depth calculated in **(a)** and subtract that from the height of water given in this question part.

(c) Candidates often used the formula P = hρg to answer this question, with many calculating the correct numerical value. Of those who used P = F/A, some forgot to convert mass to weight using F = mg. Another common mistake in otherwise correct answers was the omission of the unit.

Question 2

(a) Three elements were needed for a full answer to this question; an accurate way of determining one oscillation, the decision to time a sensible number of oscillations and the calculation necessary to determine the period from the number of oscillations timed. While most candidates identified that timing multiple oscillations was necessary, very few described carefully how to identify one oscillation by the use of some fiducial aid or mark. Weaker candidates tried to count the number of oscillations in a set time which, with a period of approximately one second, would not lead to an accurate result. Candidates needed to select a suitable number of oscillations to time, which should be enough to allow for minimising human reaction time errors but should not be so large that an unnecessary amount of time is spent measuring for no additional benefit in accuracy. The ideal range for this pendulum was around 10 – 15 oscillations (with a slightly wider range than this accepted). A common mistake was to describe timing swings without being clear that if swing means oscillation, it must clearly be both a full swing forwards and a full swing back again.

(b) Almost all candidates correctly selected apparatus for each measurement and gained full credit. A few weaker candidates measured volume of water with a digital balance or suggested a thermocouple be used to measure the thickness of a piece of aluminium foil.

Question 3

(a) (i) Most candidates gave a correct answer here, with solar panels and wind being the most popular choices. Weaker candidates sometimes gave the answer “light” which was insufficient to gain credit and a few repeated “tidal power” from the question.

(ii) Many candidates answered correctly here. A common incorrect source given was wind.

(b) (i) While most candidates knew that electricity generated from the tides is renewable, many found it challenging to explain why. A good explanation was that the tides are caused by the moon which is always present or that the tides are replenished or repeat regularly. The statement that water does not run out or get used up was insufficient as an explanation here. Another common insufficient answer described the tides as natural. A small number of candidates clearly knew, but forgot to state, that this method is renewable.

(ii) A correct answer to this question required recall and use of KE = $\frac{1}{2}mv^2$, followed by calculation of 40 per cent of that value to find the electrical output. Most candidates recalled the formula for KE, but weaker candidates often forgot to find v^2 when substituting numbers into the equation. A common mistake was to calculate 60 per cent of the KE as the electrical output and another common error was to give J as the unit.

Question 4

(a) Stronger answers explained that the air particles’ motion gave them momentum, often expressed by reference to collisions of the particles with the walls, that a change of momentum occurred on collision resulting in a force exerted on the wall and that pressure is force per unit area. Weaker answers often omitted a reference to momentum or particles, or both, as asked for in the question. The weakest candidates often attempted to explain why pressure increases with temperature or did not answer the question at all. Occasionally candidates made vague references to momentum increasing which were not creditworthy.

(b) Most candidates were able to state that the pressure increased and explained the increase, usually in terms of the particles moving faster or having more KE. Some candidates did not state the change in pressure. Candidates should be advised to read the command words in a question carefully to ensure they answer the question being asked. Here they were asked both to state any change in pressure and explain it.

(c) Correct answers here required a careful reading of the question. While many candidates recalled the formula $p_1 V_1 = p_2 V_2$ required here, only the most careful realised that the information given was the change in volume and therefore the new volume had to be calculated (i.e. 170-70). Some weaker candidates were not able to recall the formula correctly. Candidates are advised to quote a formula in symbols before any rearrangement or substitution as partial credit is available for recognising correct physics to use in a given question even if mistakes are subsequently made.

Question 5

(a) Most candidates answered this question correctly and included the correct unit in their answer. Almost all candidates were able to calculate ΔT correctly. The most common error was use of an incorrect equation.

(b) Stronger candidates identified radiation as the main process of thermal energy transfer, explained that this radiation was electromagnetic waves or infrared radiation and then described it travelling to or being absorbed by the worker. Careful reading of the question showed that only one type of radiation, the main process, was asked for and candidates who mentioned a secondary method of thermal energy transfer did not gain credit. Few candidates qualified radiation with additional detail and weaker candidates often simply restated "thermal energy is transferred to the worker" from the question. Partial credit was awarded to candidates who explained that conduction was not the main method as air is a poor conductor or who explained that convection was not the main method since convection currents would take thermal energy up above the block rather than out to the side where the worker stood.

(c) More candidates gained some credit here than in the previous question. Stronger candidates stated conduction as the main process of thermal energy transfer and then attempted an explanation in terms of either delocalised electrons moving throughout the metal, vibration of particles transferring energy to neighbouring particles, or both. Weaker candidates sometimes forgot to name the process of energy transfer and sometimes gave muddled answers about delocalised electrons transferring energy to neighbouring particles through vibrations.

Question 6

(a) (i) Many strong answers were seen here, with candidates drawing two correct rays with thin neat pencil lines, extending them backwards correctly and then drawing in and labelling the image IY. A common mistake from otherwise good constructions was to measure the height of the image rather than the distance from IY to the centre of the lens as asked for in the question. Some weaker candidates were not able to draw two correct rays, necessary for finding the image.

(ii) There were several acceptable descriptions for why this image is a virtual image. Most candidates who drew a virtual image gained at least partial credit. A common mistake was the use of vague statements such as "the image is in front of the lens" rather than the precise statement "the image is on the same side of the lens as the object". Some weaker candidates who had not drawn a virtual image gained partial credit by remembering that virtual images cannot be projected on a screen.

(b) Full credit here required the blue light ray to be incident on the prism at the same angle as the green ray (ideally along the existing path, but a parallel ray above or below was accepted), and then showing greater refraction both on entering and on leaving the prism. Most candidates gained credit for showing greater refraction on leaving the prism, but often they simply drew a parallel ray of light entering and continuing inside the prism.

Question 7

(a) Most candidates knew that field lines are from N to S and gained partial credit here. Many also knew the basic field pattern around a bar magnet and by drawing field lines carefully above and below the magnet gained further credit. Full credit required candidates to show loops above and below, carefully drawn without obviously crossing and showing a balanced pattern. Some candidates misinterpreted the question, believing that there was also a magnet at position 2 and attempting to draw field lines between the magnet and position 2.

(b) This question required an arrow, pointing towards the right-hand end of position 1. Many candidates misunderstood the question and tried to draw field lines as if there were two magnets interacting.

(c) (i) The direction of the force that the N pole of magnet 2 exerts on the N pole of magnet 1 was to the left or towards magnet 1 or away from magnet 2. Any of these answers gained credit. Many candidates were confused about which magnet was providing the force and which magnet was receiving it. Some weaker candidates mentioned the effect would be upwards or out of the page.

(ii) Very few candidates expressed their answer in terms of the force being in the direction of the magnetic field. Most candidates who gained credit here did so for realising that the force would repel magnet 1 because two like poles faced each other.

Question 8

(a) Stronger candidates correctly identified that the resistance of a thermistor decreases as light intensity increases, that this leads to a decrease in the voltage across the thermistor and that this is due to a change in the proportion of total resistance contributed by the thermistor. Several weaker candidates, while knowing how resistance and voltage changed, gave simple explanations in terms of V=IR which did not adequately explain the effect. The weakest candidates either did not know how resistance changed with light intensity or could not work out how a change in resistance affects the voltage across the thermistor.

(b) (i) Some stronger candidates were able to use **I** = Q/t correctly and then divide their value of Q by the charge on one electron to find the number of electrons passing through the resistor each second. Weaker candidates were often unable to rearrange or recall the formula correctly or made mistakes when dividing by a negative power-of-ten. A few candidates did not answer this question.

(ii) Most candidates correctly recalled $P = IV$ and used it to calculate power. Common mistakes were attempting a calculation with an incorrect formula, e.g. E = IVt

Question 9

(a) (i) Candidates are expected to be able to draw the symbols for common circuit components given in the syllabus. Some correctly recalled and reproduced a diode symbol. Common errors included forgetting the vertical line at the point of the triangle or neglecting to include horizontal wire emerging to left and/or right.

(ii) Many candidates drew a NOT gate correctly. Common mistakes here included neglecting input and/or output and in some cases the NOT gate was incorrectly drawn with two inputs.

(b) (i) Many fully correct responses to this question were seen. A common mistake was to give the output of an OR gate for Z. There were many different incorrect responses for O.

(ii) Few candidates correctly identified a NOT gate here. There were a wide variety of incorrect responses which were not generally related to the answers given for Z in **(i).**

(c) This question was answered best when candidates recognised that output 1 was the result of inputs 1 and 2 going through an OR gate and output 2 was the result of inputs 1 and 2 going through a NAND gate. Therefore, a correct design had these two gates, with inputs 1 and 2 going into each gate and the outputs correctly labelled. The strongest candidates generally produced a clear, correct circuit and gained full credit. The most common errors seen were output 1 being used as an input to the NAND (or second) gate or ambiguous shapes used to depict unlabelled gates that could not be given credit. Some candidates made no attempt at the question.

Question 10

(a) (i) Most candidates correctly stated the proton and nucleon number of an alpha particle. Weaker candidates gave a variety of incorrect responses with a few reversing the proton and nucleon numbers.

(ii) The question provided the magnitude of the charge on a beta particle. Candidates needed to realise that the charge on an alpha particle is twice the magnitude of the charge on a beta particle. Most candidates ignored the information in the question and simply put that the magnitude of the charge on an alpha particle is 2.

(b) Many candidates gave a fully correct response to this question with many more gaining partial credit. Common mistakes included using neutron, instead of nucleon numbers, or placing the beta particle on the wrong side of the nuclide equation. Some candidates made no attempt at this question.

(c) Most candidates correctly deduced that 3 half-lives had elapsed and used this to calculate the correct value of mass of radium in the sample after 279 minutes. The unit of mass was missing in several answers. Weaker candidates divided by 3 rather than by 2^3 to find the mass remaining.

PHYSICS

Paper 0625/43
Theory (Extended)

Key messages

Candidates should look carefully at units to see if they need to convert units with a prefix or non-SI unit to another unit.

Before starting their response, candidates are advised to read the questions carefully, paying attention to the command words and any context or application, to ensure they focus their answers as required.

In calculations, candidates should set out their working clearly. Credit may be given for correct working even if their final answer is incorrect.

General comments

The paper was generally answered well and the majority of candidates made an attempt at all questions. Questions where there were a slightly higher number of no response were **Questions 9(b)(iii)**, **10(b)(iii)** and **11(a)**. The area that proved particularly challenging was in **Question 8(a)** describing and explaining charging by induction.

Candidates should ensure they use a sharp pencil for diagrams and a ruler where appropriate for straight lines and avoid roughly drawn sketches, especially on graphs. A pair of compasses are ideal to use where possible for curved diffraction wavefronts, although credit is given for careful, clear freehand lines.

Attention should be given to significant figures and candidates should avoid giving their answer to only one significant figure. They should also take care not to round intermediate values midway through a longer calculation as this frequently leads to an inaccurate final answer.

Candidates should always take care to distinguish between the symbol t for time and T for temperature when writing down equations or working out.

Comments on specific questions

Question 1

(a) Candidates often wrote “a change in velocity over a time”. The use of the word ‘over’ was imprecise and should be avoided. Another common mistake was to write “rate of change of velocity” which was correct, but to mistakenly add “per unit time”. This suggests a misunderstanding of the term ‘rate’. Although credit was given for a correct equation, candidates should aim to give a precise meaning in a sentence.

(b) (i) All candidates attempted this question, and it was answered well. A common mistake was to give the units as m / s.

(ii) This question was answered well by most candidates with the use of $F = ma$. A few candidates obtained the correct answer with the use of $m\Delta v / \Delta t$.

(iii) Many candidates made some reference to air resistance and stronger candidates recognised that air resistance increases with speed. Weaker candidates often gave answers in relation to an increasing acceleration for take-off which gained no credit, or they referred to acceleration after take-off. The main misconception here was that an increasing speed with time seen on the graph, indicated an increasing acceleration.

(iv) Only the strongest candidates realised from the speed time graph that the acceleration is decreasing. Consequently, many answers showed a straight-line graph with a positive gradient. However, many of those candidates who drew a graph with decreasing gradient correctly interpreted that the line does not reach zero at 35 s. Only a few candidates recognised that the speed time graph ended with a constant gradient and therefore a constant acceleration.

Question 2

(a) (i) This question proved challenging for many candidates, and few obtained full credit. Whilst the formula for momentum was well known, and candidates made good attempts to calculate a change, they often omitted the conversion of mass to kg and very few recognised the need to take direction of velocities into account. Both errors led to incorrect answers of 1.5 or 1500.

(ii) Many candidates knew the correct equation, but a common error was to quote "rate of change of momentum = force $\times$ time", whereas the question asked for the definition of impulse, not rate of change of momentum. Impulse needed to clearly be the subject of the formula.

(iii) This question was answered well by stronger candidates.

(b) This question was answered well, and many candidates knew the correct equation for the kinetic energy. A few candidates calculated the kinetic energy before and after the impact but rounded these intermediate values to 2 significant figures, e.g. 19.604 was rounded to 20 J and 78.416 was rounded to 78 J. This led to an evaluation of 58 J for the final answer which was inaccurate. Rounding should usually only be done on the final answer to prevent this problem.

Question 3

(a) This was answered very well with most candidates gaining full credit. The most common mistake was to use open sea in place of tidal (bay).

(b) There were many varied correct advantages and disadvantages given by the candidates. The most common correct answers for an advantage were "renewable" and "doesn't produce gas pollution". The question asked for advantages and disadvantages specific to tidal power. Some answers, such as being eco-friendly, were too vague and general to gain credit. For example, "expensive to build" was required rather than "expensive" and "not available at all times" rather than "unreliable". Since tides are very reliable and predictable, the answer "unreliable" needed to be qualified in this instance. There were some good answers recognising that there are limited sites for construction around the world and that maintenance underwater is more difficult.

(c) There were varied responses to this question. Only a small number of candidates recognised that the Moon is the main source of energy for tidal power. A few candidates wrote Moon and Sun which did not gain credit since the question asked for the main source of energy. A common mistake was to reference kinetic or gravitational potential energy which showed a misunderstanding of the question.

Question 4

(a) (i) This part was generally answered well with volume being the most common correct answer. A few candidates incorrectly gave liquid as their answer which lacked the actual property.

(ii) Many stronger candidates understood that thermometer Y would be more sensitive but found it difficult to express the explanation clearly and precisely. Answers often referred to the larger amount of liquid having a larger surface area or needing more energy to expand, without relating to the temperature rise per degree Celsius. The weakest candidates thought that Y would be less sensitive because, for instance, there would be more particles requiring more heat energy to expand and therefore take longer. This highlighted the misconception that sensitivity is the same as responsiveness. Others confused sensitivity with range.

(iii) This part proved challenging for many candidates, and few obtained full credit. Even candidates who were able to give a correct change to the thermometer, struggled to write a clear explanation. Answers were often too imprecise. Explanations such as you "make the thermometer longer so you can add more number values" did not gain credit since they did not relate to the liquid. Candidates should take care to use the correct terminology in their explanations to avoid ambiguity, e.g. "make the bore wider" rather than "make it larger". Some candidates assumed that the thermometer used mercury, but this was not in the question.

(b) The strongest candidates gave a suitable property, most commonly emf or resistance of a thermocouple. Weaker candidates often gave insufficient answers, simply stating another property of liquid-in-glass thermometers, showing that they had not read the question carefully enough**.**

Question 5

(a) Although this part was challenging to weaker candidates, the vast majority tried with many gaining credit for a comparison of rate of evaporation with different dishes or with the Sun or wind. A lack of correct scientific terminology reduced the credit awarded for other marking points. Answers need to be clear that the wind was removing particles after they had left the surface. A common mistake was to suggest that the wind gives KE to the water particles so they can escape more easily, or that wind blows off the top layer of water particles. Candidates should take note when a question asks for an explanation in terms of particles. Some answers did not mention particles at all. There were some instances of ambiguity in the use of the word drought instead of draught. No credit was given for saying that no water evaporates from dish C. There will be some evaporation, but the rate of evaporation will be lower. The strongest answers described the physics of evaporation clearly and then made a statement about the rate of evaporation.

(b) This part proved challenging to weaker candidates. A common mistake was a lack of precision in the change of state. Since this is latent heat of vaporisation, it was important to make clear that it is the change between liquid and gas and not just say, for example, "energy needed for boiling". A common mistake was to say that a substance is changing. Stronger candidates gave clear definitions although some omitted "per 1 kg".

(c) Many candidates recognised the heating curve and understood that the horizontal sections of the graph indicated a change of state. Care needed to be taken with the use of the phrase "heating up" for sections A and C. This was imprecise because thermal energy is being supplied at all stages. At A and C this caused a temperature change rather than a state change. A few candidates suggested that the water was evaporating at D rather than boiling.

Question 6

(a) (i) This question was generally answered well but care needed to be taken to produce an accurate diagram using a ruler for straight lines and a protractor to measure angles.

(ii) This was answered well, and candidates clearly knew that the wavefronts should be perpendicular to the direction. A few candidates did not gain credit due to inaccuracies or inconsistencies in the wavelengths.

(b) This part was slightly more challenging than **(a)**. Diagrams needed to be drawn clearly with a thin line. Curves should be either drawn with a pair of compasses or be smooth curves. Some candidates found it hard to keep the wavelength constant throughout. Wavelengths should be equal to that of the incident wave. The question asked for wave crests after they passed through the barrier; a few candidates drew wave crests in the gap. Care needed to be taken with the amount of curvature of the crests and not to make them too shallow or have straight lines in the centre.

(c) Most candidates knew the correct equation. Candidates should always write down their working out, so they are able to gain some credit even if their final answer is incorrect.

Question 7

(a) Weaker candidates tried to explain the conditions for TIR rather than giving a definition. A common mistake was to refer to the angle of incidence and the critical angle. A few candidates confused the terms reflection and refraction.

(b) (i) All but the very weakest candidates recalled the correct formula for calculating the critical angle, but some had difficulty in rearranging it appropriately. The strongest candidates then recognised that they needed to subtract this from 90° to get the final angle.

(ii) Many candidates gave the correct answer, but a significant number omitted to give any unit.

Question 8

(a) This proved to be a challenging question with only the strongest candidates gaining full credit. Most knew that opposite charges attract but a common misconception was that the positive charges can move through the metal, or they are able to jump from the plastic rod onto the metal. A common mistake was to suggest that the negative charges flow from the metal plate down the earth wire towards earth or they jump from the metal plate to the rod in order to neutralise it. Weaker candidates showed confusion between magnetic and electric fields or attempted to describe charging by friction by rubbing the plastic rod on the metal plate.

(b) This was generally answered well. A common mistake was to confuse the flow of the electrons with the flow of conventional current.

Question 9

(a) This part was answered well by stronger candidates. Candidates should remember that answers should not generally be left as a fraction. A small number omitted the unit.

(b) (i) Many candidates recognised that the supply was a.c. and sketched some form of sine curve which gained some credit. Only stronger candidates knew that the wave would be rectified. Even then it was a challenge to draw a correctly rectified graph with many candidates simply swapping the negative section of the sine curve to positive. Full credit was only given for two accurately drawn and complete cycles.

(ii) Most candidates knew the correct value, but a significant number wrote the value against the peak rather than on the p.d. axis. Candidates needed to take care to read the instructions carefully. Some did not take care to line up the value with the maximum value of their peak. Some candidates drew a dashed line from the maximum of the peak to the y axis to indicate where the 340 should go. This was very helpful.

(iii) Most candidates were able to gain some credit here if they had arrived at some value in **(a)**. The most common mistake was to place their value for the time period at the end of the x axis after two cycles rather than halfway along the *x* axis after one cycle. Any correct time consistent with their graph and time period was accepted.

Question 10

(a) Many candidates correctly identified the alpha and beta tracks and were able to state properties of the particles which gained them credit. Only a few candidates referred to the relative energy of the two particles. Some weaker candidates thought that this was a question about deflection of particles in an electric field and talked about the curving of the lines up or down in relation to the different particles.

(b) (i) This was generally answered well with many candidates gaining full credit. A common mistake was confusing isotopes with ionization with references to gaining or losing an electron or becoming charged. Candidates needed to be aware that they did not need to mention the number of electrons in the answer to this question. A few candidates were thinking about nuclear decay and gave answers such as “an element that decays” or “an element with an unbalanced number of protons and neutron”. Careful reading of the question should have led them away from such answers. Answers referring to a different mass/nucleon number were sometimes imprecise if the number of protons had not been stated. It was better to refer to the number of neutrons.

(ii) This was well answered by many candidates. Common errors by weaker candidates were to use the neutron number in place of the nucleon number or to get all the proton numbers exchanged with the nucleon numbers. The numbers should always be to the left of the symbol. Values for the beta particle were well known.

(iii) Answers for this part were varied and even the strongest candidates found it challenging with many mistakenly referring to the penetrating power of beta particles. The question required that candidates apply their knowledge of half-life time and the idea of a stable product to the application of detecting leaks in water pipes. Candidates often ignored one or other of those properties. Saying that magnesium was safer was insufficient and some candidates suggested that it was “safer for the pipes” or “the environment”, whereas candidates needed to be clear that it is safer for humans to drink the water.

Question 11

(a) Candidates often had an idea of the correct pattern for the field lines but lack of care in the diagrams prevented them from attaining full credit. Candidates did best when they drew a few field lines carefully. Field lines should not touch or cross and many candidates drew a dense mass of lines at each end of the coil with all the lines on top of each other. Many candidates knew the correct direction of the field but there were some contradictory arrows often on the side curved lines/loops.

(b) Generally, this was answered well particularly by stronger candidates. A few made the mistake of rounding to 1 significant figure to give an answer of 900 turns. Others knew the equation and correctly wrote this down to gain partial credit before making an incorrect rearrangement and evaluation. Weaker candidates did not appear to know the equation.

PHYSICS

Paper 0625/51
Practical Test

Key messages

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

General comments

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

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

It is assumed that, as far as possible, the IGCSE course will be taught so that candidates undertake regular practical work as an integral part of their study of physics.

Questions on experimental techniques were answered much more effectively by candidates who clearly had regular experience of similar practical work and much less successfully by those who, apparently, had not. Some candidates appear to have learned sections from the mark schemes of past papers and written responses that are not appropriate to the questions in front of them.

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

Comments on specific questions

Question 1

(a) (i) Most candidates recorded a realistic value for the length of the pendulum but a significant proportion did not give the reading to the nearest mm.

(ii) Candidates were expected to give a clear explanation involving the use of a horizontal aid or ensuring that the pendulum bob was just touching the meter ruler.

(b) The majority of candidates successfully recorded increasing t values, with the first value within the accepted range, and calculated the period T correctly. The T^2 values were expected to be given either all to three significant figures or all to four significant figures.

(c) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates chose a scale that resulted in the plots occupying too small a proportion of the graph grid. Plotting was generally accurate. Candidates should use neat crosses for the plots, or neatly circled dots so that the accuracy of the plotting can be assessed. Many candidates drew a well-judged straight line although some lost the mark by drawing a 'dot-to-dot' line whilst others drew a straight line that did not match the plots.

(d) Candidates were expected to show understanding of the reaction time error being a smaller proportion of the time for 20 oscillations than for one oscillation. Some candidates appeared to refer to an average of the times taken for each of 20 separate oscillations.

Question 2

(a) Most candidates recorded a suitable current to at least two decimal places and a realistic potential difference to at least 1 decimal place. Most candidates successfully calculated the resistance R_1.

(b) Candidates were expected to record new values of I and V and obtain a value for R_2 which was less than R_1 showing that the instructions had been correctly followed. The mark for the resistance unit Ω was available here if not contradicted elsewhere.

(c) Candidates were expected to record new values of I and V and obtain a value for R_3 which was less than R_2 again showing that the instructions had been correctly followed. The value of R_3 was expected to be given to 2 or 3 significant figures.

(d) Candidates were expected to notice that the brightness of the lamp and the resistance of the lamp both decreased. Some candidates gave answers that contradicted their results.

(e) The majority of candidates drew the correct symbol for the variable resistor, but some drew a thermistor and others a symbol that was a mixture of the two. The candidates were expected to draw a circuit similar to Fig. 2.1 but with the variable resistor replacing the resistance wire and the flying lead replaced by a normal connecting lead.

Question 3

(a) Most candidates recorded a realistic room temperature.

(b) The majority of candidates successfully recorded realistic decreasing temperatures. Some recorded room temperature at time $t = 0$ however.

(c) Most candidates correctly calculated the decrease in temperature and average rate of cooling.

(d) Here candidates were required to have a starting temperature within + or -2°C of the temperature in Table 3.1 at 90 s. Most achieved this along with decreasing temperatures in Table 3.2. Candidates were expected to calculate the relevant temperature difference and rate of cooling. Here the mark for the unit for rate of cooling was awarded if correct and not contradicted in **part (c)**. A significant number of candidates either gave no unit or a wrong unit.

(e) The conclusion must link the initial temperature with the rate of cooling and quote numerical results to support the conclusion. The response must be based on the candidates' results.

(f) Candidates were expected to give two relevant responses , for example viewing the scale at right angles and taking the reading at the bottom of the meniscus.

Question 4

Candidates who followed the guidance in the question were able to write concisely and address all the necessary points. Some candidates copied the list of apparatus and other information given in the question. This was unnecessary and often introduced a vague explanation of the investigation.

A concise explanation of the method is required. Candidates should concentrate on the readings that must be taken and the essentials of the investigation. It may benefit candidates to plan their table of readings before writing the method to help them to think through the measurements that must be taken to address the subject of the investigation. Candidates were expected to describe releasing the ball to roll down the track and then measure how far it travels. An unspecific reference to repeats is not sufficient as it is not clear whether the candidate is referring to using different angles or repeating the measurements with the same angle.

The distance to be measured was the horizontal distance travelled. Some candidates addressed this and gave a good description of how this could be achieved although by having suitable reference points on the floor, maybe using a sand tray to catch the ball and leave a mark at the pint it landed. Many candidates missed this level of detail.

Candidates were expected to identify the variable that should be kept constant – the release height or using the same ball every time.

Many candidates drew a suitable table. They were expected to include columns appropriate to the method including correct units.

Candidates were expected to explain how to reach a conclusion by drawing a graph of angle against distance travelled or by comparing the angle with the distance. The question did not ask for a prediction. Some candidates wrote a prediction but no explanation of how to reach a conclusion.

PHYSICS

Paper 0625/52
Practical

Key messages

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

The ability to record readings to an appropriate precision, usually reflecting the measuring instrument being used, or to quote a derived result to an appropriate number of significant places, caused difficulty for many candidates.

Some candidates had difficulty in choosing an appropriate scale to plot their graphs and in drawing a best-fit line to display their data.

Many candidates seem less able to derive conclusions backed up by evidence, or to present well thought out conclusions.

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

General comments

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

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

The majority of candidates entering this paper were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of every practical test were attempted and there was no evidence of candidates being short of time. The majority of candidates were able to follow instructions, record observations clearly and perform calculations accurately and correctly.

Comments on specific questions

Question 1

(a) Most candidates recorded a sensible value for the temperature of the room. Temperatures recorded ranged from 20°C to 32°C.

(b) Again, values given for the temperature of the cold water θ_C and the hot water θ_H were realistic, with values ranging from 30°C to 80°C.

The temperature of the mixture θ_M, when the hot and cold water were added together was always recorded and was usually about half-way between the extremes of the cold water and the hot water temperatures.

(c) The calculation of the decrease in temperature of the hot water and the increase in temperature of the cold water were almost always correct. Occasionally, the unit was missing from the answer, despite the instruction to include the unit being given in the question.

(d) Some candidates were unaware of how to calculate the average value, θ_A, of θ_H and θ_C. Despite the instruction to show the working, many candidates just wrote down the answer for θ_A. This meant that credit for working could not be awarded, even if the answer was correct**.**

(e) Many candidates had difficulty in deciding whether the values of θ_A and θ_M were sufficiently close to conclude that they were equal within the limits of experimental error. Many candidates were unable to give a convincing justification for their statements. The idea of experimental tolerances and whether the difference between two measured quantities is close enough to zero for them to be considered equal was not well understood by most candidates. Generally, if two values differ by 10% or less, the expected answer is “yes, they are the same”. If the values differ by more than 10% the expected answer is “no, they are different”. A calculation should be given to justify the statement made.

(f) Most candidates were able to state two requirements to ensure an accurate result when reading the volume of water in a measuring cylinder. Answers were sometimes too vague, for example “view the measuring cylinder at right angles”, instead of “view the scale reading of the measuring cylinder at right angles” and “take the reading below the meniscus instead of “take the reading at the bottom of the meniscus”.

Question 2

(a) The normal to the middle of the mirror was almost always drawn accurately and in the correct place.

(b) Most candidates drew a line 7.0 cm long to represent the incident ray in the correct quadrant of **Fig. 2.1**, and at an angle of incidence of α = 30° to the normal, as instructed. The most common error was to use the protractor incorrectly and draw a line 7.0 cm long at α = 60°. Despite the instruction to label the end of the line with the letter A, the label was often missing.

(c) The position of the pins P_3 and P_4, indicating the direction of the reflected ray were usually in the correct area of the diagram. For accurate ray tracing, the positions of pins P_1 and P_2 should be at least 5.0 cm apart. This was frequently not the case.

(d) Angle β was usually measured correctly to $\pm$ 2°, the tolerance allowed for the measurement of the angle.

(e) The procedure was usually repeated correctly for the new angle of incidence α = 45°.

(f) The values of ($\alpha + \beta$) for both angles of incidence α were almost always calculated correctly.

(g) Only stronger candidates were able to suggest a relationship between the two values of ($\alpha + \beta$) they had just calculated. These candidates identified that the two values of ($\alpha + \beta$) were the same (allowing for experimental error). Answers saying that the values of ($\alpha + \beta$) are close/almost equal/not too far apart, were also accepted.

(h) There were few completely correct answers to this part. Candidates were asked to suggest further values for the angle of incidence α that they could use to extend the investigation. Many correctly suggested values of α > 45° (and < 90°), and gained credit. Far fewer suggested any angle α < 30°. A sizeable minority of candidates quoted values of α > 90°, which showed a lack of understanding of the term ‘angle of incidence’.

(i) The practical reasons why the results obtained may not be exactly those that the theory of reflection predicts were not well known. The main difficulty, which was not apparent to the majority of candidates, is the difficulty in lining up the pins P_3 and P_4 with the images of P_1 and P_2 so that they all appear exactly one behind the other. This should have been clear to candidates considering they had just done the experiment. Answers such as "the pins were too thick" or "the lines drawn to represent the rays were too thick" were also accepted.

Question 3

(a) Almost all candidates recorded a sensible value for the scale reading on the metre ruler at the point where the unloaded metre rule balanced on the pivot.

(b) Most candidates performed the experiment correctly and produced a fully completed table of results showing that the distance *a* between the loads P and Q at balance decreased, as the load P was increased. The values of *a* were also usually recorded to the nearest millimetre.

(c) Despite the instruction given in the question to start the *y*-axis at $a = 30$ cm, many candidates ignored this. The unit for 1 / P caused considerable difficulty, with only stronger candidates giving 1 / N or N^{-1}. The most common incorrect unit given was N.

There was little evidence of the use of scales that increased in inconvenient increments, such as 3 or 7. Choosing such scales makes the points much harder to plot by the candidates and more difficult for candidates' plotted points to be checked.

There were many excellent, carefully drawn, best-fit lines produced by candidates. However, there were many graphs where the attempt at a best-fit line resulted in all points which did not lie on the drawn line being on the same side of the line. A minority of the lines drawn were forced through the origin.

There were also some graphs where the points were joined dot-to-dot. The concept of best fit was clearly not well understood by all candidates.

(d) The use of the graph to find the value of *a* when the ratio 1 / P = 0 was done well by most candidates. The instruction to show clearly on the graph how the necessary information had been obtained was often missing and so only partial credit was obtained for the question.

Question 4

Credit was available for candidates completing the circuit diagram given in **Fig. 4.1** to show a voltmeter connected to measure the potential difference across the relevant portion of the resistance wire. The majority of candidates knew that the voltmeter needed to be connected in parallel with the resistance wire, and drew it as such, without thinking about the exact length of the wire that was actually in the circuit. Credit was only awarded if the voltmeter was connected across the length of wire between the crocodile clips or connected across the power supply.

Further credit was available for giving a brief explanation of how the investigation would be carried out. Most candidates understood what the investigation involved and described a set-up where a clamped metal wire was loaded and the potential difference V across the wire and the current I in the wire were measured. This was then repeated for at least two other loads. Far fewer candidates stated that the resistance of the wire should be calculated for each pair of readings of V and I recorded.

Few candidates gained the credit available for stating the control variable in this investigation, namely that length of resistance wire between the crocodile clips should remain constant. Most candidate just stated that the length of the resistance wire should be kept constant.

Most candidates drew an appropriate table of results and gave relevant headings with units. The terms load, mass, number of loads were allowed instead of tension. The unit given here needed to be consistent with the term used. Few candidates explained satisfactorily how they would use their results to reach a conclusion, because they made predictions about the outcome. An answer such as "compare the load with the resistance to see if there is an effect" was expected. Many stronger candidates also suggested plotting a graph of load against resistance and using the graph to draw a conclusion.

PHYSICS

Paper 0625/53
Practical

Key messages

Candidates need to have a thorough grounding in practical work during the course and should have had significant experience in carrying out experiments. This should include what is needed to improve reliability in experimental work and how to identify which variables need to be controlled.

This paper tests an understanding of experimental techniques and explanations need to be based on data with practical rather than theoretical considerations being taken.

Direct measurements should always be taken to the relevant level of accuracy, with calculations stated to the required, and consistent, number of significant figures or decimal places. Clear calculations, with the correct units, should always be shown.

Candidates should read all questions carefully to ensure they can provide a fully relevant response.

General comments

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

- graph plotting
- manipulating data to obtain results
- drawing conclusions
- tabulating readings with correct units
- control of variables
- dealing with possible sources of error
- understanding the concept of results being equal within the limits of experimental accuracy
- choosing appropriate apparatus
- taking measurements to the required accuracy.

It is assumed that as far as possible the course will be taught to enable candidates to have regular experience of practical work as a main part of their study of physics.

All parts of all questions were attempted and successfully completed within the allotted time. Most candidates followed the instructions and performed the calculations to the required accuracy.

Each practical examination will include a question where candidates will be asked to plan an investigation. These answers should be based on careful reading of the question and a logical application of good experimental practice.

Comments on specific questions

Question 1

(a) Most candidates successfully measured the height of the water either by viewing the level perpendicularly or at eye level. No credit was awarded for referring to the meniscus.

(b) The vast majority of candidates successfully took the five readings of *h.*

(c) Most candidates calculated *H* correctly, but a few were not consistent with their decimal points.

(d) Most candidates labelled the axes correctly with the appropriate quantities and units. There were only a few inappropriate scales (e.g., 3, 7, or 15) and most candidates had scales that occupied at least half the available grid. Many candidates successfully plotted their points, but some used large blobs, which was not acceptable. Using a small 'x' is recommended. The quality of line drawing was good with only a few thick or dot-to-dot lines seen.

(e) (i) It was essential that the values used for the calculation of *G* can be seen from the graph, ideally by a triangle being drawn.

(ii) Most candidates calculated *D* from their gradient.

(f) Many candidates realised that the bottom of the tube was curved or round and gained credit here.

(g) Very few candidates realised that this question required an answer relating to the large uncertainty that there would be in their results. Many just referred to accuracy which gained no credit.

Question 2

(a) Most candidates successfully took the required readings, with some getting repeated values for the temperature.

(b) (i) Some candidates did not have B cooling less quickly than A but did take the readings to the correct accuracy.

(ii) Some candidates did not see that there was a question here and so left the answer blank.

(c) Many candidates correctly referred to the relative cooling rates of the beakers and compared the temperature changes but then did not consider the full 180 seconds to use in their comparison.

(d) (i) Most candidates stated the correct unit.

(ii) Most candidates stated the correct values, with some incorrectly rounded up values seen.

(e) (i) Most candidates referred to experiments done previously rather than suggesting a new one. These included using coloured card, or a lid rather than a shiny black surface

(ii) Most candidates correctly identified a variable that should be controlled with initial temperature and volume of water being most frequently seen. Any reference to time was not credited.

(iii) There were very few correct answers. Many answers just referred to **(i)** incorrectly.

Question 3

(a) (i) Many candidates correctly measured *V* and I_T to the required decimal places.

(ii) Many correct calculations of R_{PQ} were seen with candidates stating their answer to 2 or more significant figures.

(iii) Most candidates correctly measured V_S and that $V_S > V$ and calculated R_S to either 2 or 3 significant figures.

(b) Most candidates correctly measured I_P and stated that it was less than I_T

(c) Most candidates correctly read the value of I_Q and used correct units throughout this question.

(d) A statement matching the candidates own results and that comparative values were seen was needed along with a comment that their results were within experimental limits. If candidates stated that their values did not support this suggestion, then the statement that they were beyond experimental limits needed to be seen.

(e) (i) Many candidates did not draw the correct symbol but fewer placed an 'x' on the circuit diagram.

(ii) The vast majority of candidates recognised that there would be an increased difficulty in using multiple resistors, usually as a result of disconnecting and reconnecting the circuit. The most common errors were basic statements that multiple resistors are less accurate or that too much heat would be generated. Very few candidates stated that a variable resistor gives a range of continuous data.

Question 4

It is essential that candidates use the bullet points as guidance when producing their plan. Those candidates that did usually gave answers that were more complete.

Many candidates identified temperature as the independent variable, but some did not include a thermometer in their additional apparatus.

Most candidates successfully described the method of heating the ball in a beaker of water, then dropping the ball and then measuring the height of the bounce. Some candidates heated the ball directly in a Bunsen flame or proceeded to bounce the ball. Neither point gained any credit.

Many candidates noted that a range of further temperatures was required, but fewer recognised that readings should be repeated and an average calculated. Many candidates stated that at least 5 sets of data was required.

There were many instances of good tables being drawn, with correct heading and units seen.

Many candidates successfully compared the relationship between the independent variable (temperature) and dependent variable (bounce height), usually by means of an appropriately labelled line graph.

A comparison rather than a conclusion was required i.e. do the readings in the table show that a change in temperature produce a change in the bounce height?

PHYSICS

Paper 0625/61
Alternative to Practical

Key messages

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

General comments

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

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

It is assumed that, as far as possible, the IGCSE course will be taught so that candidates undertake regular practical work as an integral part of their study of physics.

Questions on experimental techniques were answered much more effectively by candidates who clearly had regular experience of similar practical work and much less successfully by those who, apparently, had not. Some candidates appear to have learned sections from the mark schemes of past papers and written responses that are not appropriate to the questions in front of them.

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

Comments on specific questions

Question 1

(a) Candidates were expected to give a clear explanation involving the use of a horizontal aid or ensuring that the pendulum bob was just touching the meter ruler.

(b)(i),(ii) The majority of candidates successfully calculated the period T correctly. The T^2 value was expected to be correctly rounded and given to two decimal places.

(c) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates chose a scale that resulted in the plots occupying too small a proportion of the graph grid. Plotting was generally accurate. Candidates should use neat crosses for the plots, or neatly circled dots so that the accuracy of the plotting can be assessed. Many candidates drew a well-judged straight line although some lost the mark by drawing a 'dot-to-dot' line whilst others drew a straight line that did not match the plots.

(d) Candidates were expected to show the triangle method clearly on the graph and use a large triangle.

(e) Candidates were expected to show understanding of the reaction time error being a smaller proportion of the time for 20 oscillations than for one oscillation. Some candidates appeared to refer to an average of the times taken for each of 20 separate oscillations.

Question 2

(a) Many candidates drew the correct symbol across the lamp but others placed the voltmeter in series with the lamp or across the resistance wire.

(b)(i),(ii) Most candidates recorded the correct potential difference and current readings and went on to successfully calculate the resistance R_1.

(c) The value of R_2 was expected to be given to 2 or 3 significant figures. Candidates were expected to record new values of I and V and obtain a value for R_2 which was less than R_1 showing that the instructions had been correctly followed.

(d) The mark for the resistance unit Ω was available here if not contradicted elsewhere.

(e) Candidates were expected to realise that the brightness of the lamp and the resistance of the lamp both decreased. Some candidates gave an answer that contradicted their results.

(f) The majority of candidates drew the correct symbol for the variable resistor, but some drew a thermistor and others a symbol that was a mixture of the two. The candidates were expected to draw a circuit similar to Fig. 2.1 but with the variable resistor replacing the resistance wire and the flying lead replaced by a normal connecting lead.

Question 3

(a) Most candidates recorded the correct room temperature, 23°C, but some quoted 20.3°C.

(b) The majority of candidates successfully recorded the times.

(c) Most candidates correctly calculated the decrease in temperature and average rate of cooling but a significant number of candidates either gave no unit or a wrong unit.

(d) Most candidates correctly calculated the decrease in temperature and average rate of cooling.

(e) The conclusion must link the initial temperature with the rate of cooling and quote numerical results to support the conclusion. The response must be based on the candidates' results.

(f) Candidates were expected to give two relevant responses, for example viewing the scale at right angles and taking the reading at the bottom of the meniscus.

(g) Two relevant variables were expected. For example the volume of water and room temperature.

Question 4

Candidates who followed the guidance in the question were able to write concisely and address all the necessary points. Some candidates copied the list of apparatus and other information given in the question. This was unnecessary and often introduced a vague explanation of the investigation.

A concise explanation of the method is required. Candidates should concentrate on the readings that must be taken and the essentials of the investigation. It may benefit candidates to plan their table of readings before writing the method to help them to think through the measurements that must be taken in order to address the subject of the investigation. Candidates were expected to describe releasing the ball to roll down the track and then measure how far it travels. An unspecific reference to repeats is not sufficient as it is not clear whether the candidate is referring to using different angles or repeating the measurements with the same angle.

The distance to be measured was the horizontal distance travelled. Some candidates addressed this and gave a good description of how this could be achieved although by having suitable reference points on the floor, maybe using a sand tray to catch the ball and leave a mark at the point it landed. Many candidates missed this level of detail.

Candidates were expected to identify the variable that should be kept constant – the release height or using the same ball every time.

Many candidates drew a suitable table. They were expected to include columns appropriate to the method including correct units.

Candidates were expected to explain how to reach a conclusion by drawing a graph of angle against distance travelled or by comparing the angle with the distance. The question did not ask for a prediction. Some candidates wrote a prediction but no explanation of how to reach a conclusion.

PHYSICS

Paper 0625/62
Alternative to Practical

Key messages

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

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

The ability to record readings to an appropriate precision, usually reflecting the measuring instrument being used, or to quote a derived result to an appropriate number of significant places, was challenging for many candidates.

Some candidates found it difficult to choose an appropriate scale to plot their graphs and to draw a best-fit line to display their data.

Candidates sometimes found it challenging to derive conclusions from given experimental data and justify them.

General comments

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

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

Most candidates entering this paper were well prepared and the range of practical skills being tested proved to be accessible to them. Most candidates showed that they were able to draw upon their own personal practical experience to answer the questions. No parts of any question proved to be inaccessible to candidates and there was no evidence of candidates running short of time. Most candidates were able to follow instructions, record measurements clearly and perform calculations accurately and correctly. Units were well known and were usually included. Writing was legible and ideas were expressed logically

Comments on specific questions

Question 1

(a) Most candidates read the scale of the thermometer correctly and stated that room temperature was 23°C. The most common incorrect answers were 20.3°C and 37°C.

(b) The precautions needed to be taken to obtain an accurate value for the highest temperature of the cold/hot water mixture were well known. The most popular correct answers were perpendicular viewing of the scale of the thermometer and stirring the water before taking the temperature. Less popular, but equably acceptable correct answers were to ensure that the thermometer is not touching the sides of the beaker and to wait for the thermometer reading to stop rising before reading the temperature.

The calculation of the decrease in temperature of the hot water and the increase in temperature of the cold water were almost always correct. Occasionally the unit was missing from the answer, despite the instruction to include the unit being given in the question.

(c) A sizeable minority of candidates were unaware of how to calculate the average value, θ_A, of θ_H and θ_C. Despite the instruction to show the working, many candidates just wrote down the answer for θ_A. This meant that no credit could be awarded for correct working**.**

(d) Many candidates had difficulty in deciding whether the values of θ_A and θ_M were sufficiently close to conclude that they were equal within the limits of experimental error. Candidates were often unable to give a convincing justification for their statements. The idea of experimental tolerances, and whether the difference between two measured quantities is close enough to zero for them to be considered equal, was not well understood by most candidates. Generally, if two values differ by 10 per cent or less, the expected answer is “yes, they are the same”. If the values differ by more than 10 per cent the expected answer is “no, they are different”. A calculation should be given to justify the statement made.

(e) Most candidates were able to state two requirements to ensure an accurate result when reading the volume of water in a measuring cylinder. Answers were sometimes too vague, for example “view the measuring cylinder at right angles”, instead of “view the scale reading of the measuring cylinder at right angle” and “take the reading below the meniscus” instead of “take the reading at the bottom of the meniscus”.

Question 2

(a) The normal to the middle of the mirror was almost always drawn accurately and in the correct place.

(b) Most candidates drew a line 7.0 cm long to represent the incident ray in the correct quadrant of **Fig. 2.1**, and at an angle of incidence of $\alpha = 30°$ to the normal, as instructed. The most common error was to use the protractor incorrectly and draw a line 7.0 cm long at $\alpha = 60°$. Despite the instruction to label the end of the line with the letter A, the label was often missing.

(c) For accurate ray tracing, the positions of pins P_1 and P_2 should be at least 5.0 cm apart. Most candidates suggested a distance greater than this and within the accepted tolerance range of between 5.0 cm and 15.0 cm.

(d) Angle β was usually measured correctly to $\pm$ 2°, the tolerance allowed for the measurement of the angle. The units of angles were usually included in the table headings. However, some candidates gave °C as the unit.

(e) The values of $(\alpha + \beta)$ for both angles of incidence α, were almost always calculated correctly.

(f) Only stronger candidates were able to suggest a relationship between the two values of $(\alpha + \beta)$ they had just calculated. These candidates identified that the two values of $(\alpha + \beta)$ were the same (allowing for experimental error). Answers such as that the values of $(\alpha + \beta)$ are close / almost equal / not too far apart, were also accepted.

(g) There were few completely correct answers to this part. Candidates were asked to suggest further values for the angle of incidence α that they could use to extend the investigation. Many correctly suggested values of $\alpha > 45°$ (and $< 90°$), and gained credit. Far fewer suggested any angle $\alpha < 30°$. A sizeable minority of candidates quoted values of $\alpha > 90°$, which showed a lack of understanding of the term angle of incidence.

(h) The practical reasons why the results obtained may not be exactly those that the theory of reflection predicts were not well known. The main difficulty, which was not clear to most candidates, was the difficulty in lining up the pins P_3 and P_4 with the images of P_1 and P_2 so that they all appeared exactly one behind the other. Answers such as suggesting that the pins were too thick or that the lines drawn to represent the rays were too thick were also accepted.

Question 3

(a) The scale reading on the metre ruler at the point where the unloaded metre rule balanced on the pivot was almost always recorded correctly as 48.8 cm.

(b) Only a minority of candidates correctly stated that to obtain an accurate value for the scale reading at balance, it was necessary to view the scale perpendicularly. Many candidates stated that the scale should be viewed at eye level, but this comment was inappropriate here as the scale was being viewed from above and not from the side.

(c) The unit for 1 / P caused considerable difficulty, with only stronger candidates giving 1 / N or N^{-1}. The most common incorrect unit given was N.

(d) Despite the instruction given in the question to start the *y*-axis at *a* = 30 cm, many candidates did not do this. There was little evidence of the use of scales that increased in inconvenient increments, such as 3 or 7. Choosing such scales makes the points much harder to plot by candidates and more difficult for the candidates' plotted points to be checked.

There were many excellent, carefully drawn, best-fit lines produced. However, there were many graphs where the attempt at a best-fit line resulted in all points which did not lie on the drawn line being on the same side of the line. A minority of the lines drawn were forced through the origin. There were also some graphs where the points were joined dot-to-dot. The concept of best fit was not well understood by all candidates.

(e) The use of the graph to find the value of *a* when the ratio 1 / P = 0 was done well by most candidates. The instruction to show clearly on the graph how the necessary information had been obtained was often missing and only partial credit obtained for the question.

(f) Only stronger candidates answered this fully correctly. Candidates were expected to take their gradient value *G* from **(e)** and record its value to a suitable number of significant figures for the experiment, which in this case was 2 or 3 significant figures.

Question 4

Credit was available for candidates completing the circuit diagram given in **Fig. 4.1** to show a voltmeter connected to measure the potential difference across the relevant portion of the resistance wire. The majority of candidates knew that the voltmeter needed to be connected in parallel with the resistance wire, and drew it as such, without thinking about the exact length of the wire that was actually in the circuit. Credit was only awarded if the voltmeter was connected across the length of wire between the crocodile clips or connected across the power supply.

Further credit was available for giving a brief explanation of how the investigation would be carried out. Most candidates understood what the investigation entailed and described a set-up where a clamped metal wire was loaded and the potential difference V across the wire and the current I in the wire were measured. This was then repeated for at least two other loads. Far fewer candidates stated that the resistance of the wire should be calculated for each pair of readings of V and I recorded.

Few candidates gained the available credit for stating the control variable in this investigation, namely that the length of resistance wire between the crocodile clips should remain constant. Most candidates just stated that the length of the resistance wire should be kept constant.

Most candidates drew an appropriate table of results and gave relevant headings with units. The terms load, mass, number of loads were allowed instead of tension. The unit given here needed to be consistent with the term used.

Fewer candidates explained satisfactorily how they would use their results to reach a conclusion, because they made predictions about the outcome. An answer such as "compare the load with the resistance to see if there is an effect" was expected. Many stronger candidates also suggested plotting a graph of load against resistance and using the graph to draw a conclusion.

PHYSICS

Paper 0625/63
Alternative to Practical

Key messages

Candidates need to have a thorough grounding in practical work during the course and should have had significant experience in carrying out experiments. This should include what is needed to improve reliability in experimental work and how to identify which variables need to be controlled.

This paper tests an understanding of experimental techniques and that explanations need to be based on data with practical rather than theoretical considerations being taken.

Direct measurements should always be taken to the relevant level of accuracy, with calculations stated to the required, and consistent, number of significant figures or decimal places. Clear calculations, with the correct units, should always be shown.

Candidates should read all questions carefully to ensure they can provide a fully relevant response.

General comments

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

- graph plotting
- manipulating data to obtain results
- drawing conclusions
- tabulating readings with correct units
- control of variables
- dealing with possible sources of error
- understanding the concept of results being equal within the limits of experimental accuracy
- choosing appropriate apparatus
- taking measurements to the required accuracy.

It is assumed that as far as possible the course will be taught so as to enable candidates to have regular experience of practical work as a main part of their study of physics.

All parts of all questions were attempted and successfully completed within the allotted time. Most candidates followed the instructions and performed the calculations to the required accuracy.

Each practical examination will include a question where candidates will be asked to plan an investigation. These answers should be based on careful reading of the question and a logical application of good experimental practice.

Comments on specific questions

Question 1

(a) Most candidates stated that the water level should be read at eye level or perpendicular to it, with a supporting diagram being seen on many occasions.

(b) Some candidates did not measure the height to the required 1 decimal point. This was to make it consistent with the other given readings.

(c) Almost all candidates gained credit here either with a correct answer or a correct calculation from their value of *h.*

(d) Most candidates labelled the axes correctly with the appropriate quantities and units. There were very few inappropriate scales (e.g., 3, 7 or 15) and candidates had scales that occupied at least half the available grid. Many candidates successfully plotted their points, but some used large blobs, which was not acceptable. Using a small 'x' is recommended. The quality of line drawing was good with only a few thick or dot-to-dot lines being seen.

(e) (i) It was essential that the values used for the calculation of *G* could be seen from the graph, ideally by a triangle being drawn.

(ii) Most candidates calculated *D* from their gradient.

(f) Many candidates realised that the bottom of the tube was curved or round and gained credit here.

(g) Very few candidates realised that this question required an answer relating to the large uncertainty there would be in their results. Many just referred to accuracy which gained no credit.

Question 2

(a) Almost all candidates correctly read the value of θ_R with only a few stating the reading was 20.2 °C.

(b) (i) Most candidates correctly stated that the thermometer should be read perpendicular to it or waiting for the temperature to stop rising. A few candidates just stated that the temperature should stop changing. This gained no credit.

(ii) Some candidates did not see that there was a question here and so left the answer blank.

(c) Many candidates correctly referred to the relative cooling rates of the beakers and compared the temperature changes but then did not consider the full 180 seconds to use in their comparison.

(d) (i) Most candidates correctly stated the unit, and correctly carried out the required calculation.

(ii) Most candidates stated the correct values, with some incorrectly rounded up values seen.

(e) (i) Most candidates referred to experiments done previously rather than suggesting a new one. These included using coloured card, or a lid rather than a shiny black surface

(ii) Most candidates correctly identified 2 variables that should be controlled with initial temperature and volume of water the most frequently seen. Any reference to time was not credited.

(iii) There were very few correct answers. Many answers just referred to **(i)** incorrectly.

Question 3

(a) Some candidates did not give a response to this question. A few added the voltmeter in series rather than in parallel with P and Q.

(b) (i) Most candidates scored full credit, with some incorrectly stating V = 1.40 V.

(ii) Most candidates calculated the value of R_{PQ} and used the correct units throughout this question

(c) Many candidates only gave the value of R_s to a whole number and did not gain credit.

(d) (i) Most candidates did not give the value of I_P to the required 2 decimal places.

(ii) Candidates needed to give a statement matching their own results and comparative values along with a comment that their results were within experimental limits. If candidates stated that their values did not support this suggestion, then the statement that they were beyond experimental limits needed to be seen.

(e) (i) Many candidates did not draw the correct symbol and fewer placed an 'x' on the circuit diagram.

(ii) Most candidates recognised that there would be an increased difficulty in using multiple resistors, usually as a result of disconnecting and reconnecting the circuit. The most common errors were basic statements that multiple resistors are less accurate or that too much heat would be generated. Very few candidates stated that a variable resistor gives a range of continuous data.

Question 4

It is essential that candidates use the bullet points as guidance when producing their plan. Those candidates that did usually produced more complete responses.

Many candidates identified temperature as the independent variable but did not include a thermometer in their additional apparatus.

Most candidates successfully described the method of heating the water in a beaker of water, then dropping the ball and then measuring the height of the bounce. Some candidates heated the ball directly in a Bunsen flame or proceeded to bounce the ball. Neither point gained any credit.

Many candidates noted that a range of further temperatures was required, but fewer recognised that that readings should be repeated and an average calculated. Many candidates stated that at least 5 sets of data was required.

There were many instances of good tables being drawn, with correct headings and units seen.

Many candidates successfully compared the relationship between the independent variable (temperature) and dependent variable (bounce height), usually by means of an appropriate labelled line graph.

A comparison rather than a conclusion was required i.e. do the readings in the table show that a change in temperature produce a change in the bounce height?