PHYSICS

Paper 0625/11
Multiple Choice (Core)

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

General comments

In 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

A number of weaker candidates thought that mass could be determined by lowering an irregular object into a measuring cylinder half-full of water.

Question 2

Most candidates thought that the heavier stone would reach the floor first.

Question 3

Only stronger candidates answered this question well, with other responses evenly spread over the options. Candidates had to translate minutes into hours and to recognise that average speed is total distance divided by total time.

Question 4

Only stronger candidates had a secure understanding of the conservation of mass.

Question 6

Weaker candidates did not subtract the mass of the empty flask in order to find the mass of the liquid.

Question 10

While stronger candidates answered correctly, a large number of other candidates believed that shining a light onto a block of iron does not transfer energy. For that to be true, the block would have to be reflecting the light perfectly, which is impossible.

Question 11

Weaker candidates did not realise that for the box to gain energy, work must be done on it, and that for work to be done, movement in the direction of the applied force is needed.

Question 12

To answer this question, candidates needed to know the formula for pressure and to be careful about unit conversions.

Question 13

The most popular option was **C**, indicating that many candidates did not know that there is a vacuum above the mercury.

Question 17

Only stronger candidates identified mass as the non-thermometric property. Other candidates were unable to demonstrate a secure knowledge of this area.

Question 18

Many candidates were able to spot the connection between a greater thermal capacity and a greater quantity of energy being needed, but then some confused thermal capacity with latent heat.

Question 19

Many candidates correctly identified that a longer strip of wax would melt but only the strongest of these were able to extend that idea to the earlier dropping of the pin.

Question 21

Only stronger candidates identified this wave as longitudinal.

Question 22

This question was usually answered well. The most common error was to confuse refraction and diffraction.

Question 23

Many candidates found this question challenging. At angles *infinitesimally* larger than θ, no light will emerge, so this is indeed the critical angle. And since the question declares that there is *some* light not travelling along the reflection path, it cannot be *total* internal reflection.

Question 26

While stronger candidates answered correctly, many weaker candidates chose option **B**.

Question 27

As many candidates selected option **A** as the correct option, **B**.

Question 29

The most popular response was **A**, possibly because candidates did not read the question carefully enough and were expecting negatively charged rods.

Question 30

While some candidates successfully added the two resistances, many then divided the total resistance by the potential difference rather than the other way round.

Question 33

This question proved challenging for many candidates and only the strongest had a secure concept of the role of a fuse to protect the cables between it and the appliance from overheating.

Question 36

A significant number of weaker candidates thought that one or other of the suggestions would have no effect.

Question 40

A significant number of weaker candidates thought that the half-life was half of the maximum time shown on the horizontal axis.

PHYSICS

Paper 0625/12
Multiple Choice (Core)

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

General comments

In 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 2

Option **A** was nearly as popular as the correct option, **B**. This was probably as a result of candidates not noticing that the various graphs had differently labelled vertical axes.

Question 3

Many candidates thought that the heavier stone would reach the floor first.

Question 6

Many candidates were successful in answering this question. The most common error was to fail to subtract the initial 40 cm^3 before dividing the volume into the mass.

Question 7

A number of candidates decided that there are no vertical forces on the car in spite of having presumably rejected as false the statement that there is no gravitational force acting on the car.

Question 9

A number of weaker candidates thought that kinetic energy was being converted into gravitational potential energy.

Question 11

Some candidates correctly identified that man Y does the most work but failed to see that this work would result in the box gaining energy. Instead, they suggested that P would gain lots of energy, in spite of the fact that the box does not move.

Question 12

Although the correct option was frequently chosen, the other options were all popular choices. To answer correctly, candidates needed to know the formula for pressure, and to be careful about unit conversions.

Question 13

Only stronger candidates recognised that $p = \rho gh$ does not include a term for area.

Question 16

Option **B** was the most common incorrect answer, but stronger candidates answered this correctly.

Question 17

While the strongest candidates answered this correctly, the most popular choice was option **C**, followed fairly closely by option **A**.

Question 18

Most candidates were able to identify the connection between a greater thermal capacity and a greater quantity of energy being needed, but many others confused thermal capacity with latent heat.

Question 21

Most candidates recognised diffraction, but others confused it with refraction.

Question 22

Weaker candidates thought that the image in a plane mirror is inverted.

Question 24

A significant number of candidates were able to apply logical thinking to this situation and identified the correct answer.

Question 25

The most popular option was **B**. Candidates needed to be clear that when a wavy line drawn to represent a longitudinal wave, it is not a picture of the wave but is a graph showing how the pressure or the longitudinal displacement is behaving.

Question 27

Option **A** was almost as popular as the correct option, **D**. Many candidates, finding that **A** fitted the facts, may have concluded that this must be the answer.

Question 30

A number of candidates, having successfully determined the resistance of X, did not take the final step of subtracting that value from the target value.

Question 32

Stronger candidates were able to perform the two calculations and then inspect the options to see which one fitted.

Question 33

Candidates needed to realise that choosing a fuse is not a matter of selecting the nearest value. It has to be the nearest value above the expected current.

Question 38

This was a detailed question involving several calculations. Stronger candidates were able to do this and selected the correct answer.

Question 39

Only stronger candidates were aware that it is the nucleus that decays and answered this correctly.

Question 40

A number of weaker candidates thought that the half-life was half of the maximum time shown on the horizontal axis.

PHYSICS

Paper 0625/13
Multiple Choice (Core)

There were too few candidates for a meaningful report to be produced.

PHYSICS

Paper 0625/21
Multiple Choice (Extended)

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

General comments

Many of the questions were answered correctly by the majority of candidates.

Comments on specific questions

Question 3

A significant number of candidates incorrectly chose option **D**. This was probably based on it being the lightest of the balls.

Question 7

The most popular option was **A**, implying that candidates had multiplied force by mass to obtain the resultant force, and had then not performed the necessary subtraction.

Question 8

A majority of candidates subtracted the two velocities without taking into account the fact that the final velocity is of the opposite sign to the initial velocity. So they obtained a velocity change of 2 m / s instead of 4 m / s.

Question 10

A significant number of candidates believed that shining a light onto a block of iron does not transfer energy. For that to be true, the block would have to be reflecting the light perfectly, which is impossible.

Question 11

A significant number of candidates did not notice that the time needed converting to seconds.

Question 12

Although stronger candidates answered this question correctly, many others did not. Candidates needed to know the formula for pressure, and to be careful about the conversion of units.

Question 13

Many candidates thought that the pressure in the Torricellian vacuum is above atmospheric pressure but stronger candidates answered correctly.

Question 19

A large number of candidates did not recognise that atomic vibrations transfer energy to the free electrons and receive it at the destination.

Question 20

Option **A** was a common incorrect choice, probably because candidates recognised than black surfaces are better emitters than white surfaces. This was in spite of the fact that the question stated that the black surface is emitting less radiation in this case and that conductors of radiation makes no sense in this context.

Question 21

Although stronger candidates answered this correctly, a number of other candidates selected option **A**.

Question 22

A significant number of candidates forgot to take the sines of the angles.

Question 23

Only stronger candidates answered this correctly. At angles *infinitesimally* larger than θ, no light will emerge, so this is indeed the critical angle. And since the question declares that there is *some* light not travelling along the reflection path, it cannot be *total* internal reflection.

Question 25

Stronger candidates answered correctly. However, a large number of other candidates did not notice the 'there-and-back' nature of the situation, and others did not convert from km to m.

Question 27

Candidates were not expected to know any of the relative velocities, but they should know that sound travels considerably faster in solids than in gases or liquids.

Question 28

Nearly as many candidates selected option **A** as the correct option, **B**.

Question 30

There was a common belief that positive ions can move around in a metal. It is just the electrons that do the moving.

Question 32

Many candidates found this question challenging. When the resistance of the LDR is low, the p.d. across it is low and vice versa, so that eliminates **A** and **B**. Candidates then needed to be clear that, in dim lighting, the LDR's resistance is high.

Question 33

Only the strongest candidates answered this correctly. The right-most gate is a NAND, so it will give 0 when 1’s are present on both of its inputs, but a 1 otherwise. The two left-most gates are operating as inverters, so the overall output will be 0 when both inputs are 0’s and 1 otherwise. This is the behaviour expected from an OR gate.

PHYSICS

Paper 0625/22
Multiple Choice (Extended)

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

General comments

Many of the questions were answered correctly by the majority of candidates.

Comments on specific questions

Question 2

A large number of candidates selected option **D**. This was probably based on it being the lightest of the balls.

Question 8

A number of candidates incorrectly chose option **B**. They correctly dealt with the mass units, and they knew about impulse being equal to change of momentum. The idea of the rebound velocity being negative following the change in direction was more challenging.

Question 10

A significant number of candidates chose option **C**.

Question 16

Option **B** was the most popular incorrect answer but most stronger candidates answered correctly.

Question 17

Although most stronger candidates answered this well, option **B** was a popular choice among other candidates. A thermometer with this characteristic would be described as having a linear scale rather than being sensitive.

Question 19

Many weaker candidates incorrectly chose option **D**.

Question 20

The concept tested in the question was not well understood by many candidates.

Question 21

A large number of candidates incorrectly selected option **A**.

Question 22

Many candidates forgot to take the sines of the angles.

Question 24

A significant number of candidates incorrectly chose option **C**. They only needed to continue the two rays on the question paper to discover their error.

Question 26

Candidates were not expected to know any of the relative velocities, but they should know that sound travels considerably faster in solids than in gases or liquids.

Question 31

A large number of candidates believed that positive ions can move around in a metal. It is only the electrons that do the moving.

Question 34

Only stronger candidates answered this well. Other candidates found this challenging. The AND gate in the middle gives a 1 if both of its inputs are 1. Since the inputs have inverters on them, the AND gate will give a 1 only if both inputs to the whole circuit are 0. This is the behaviour expected of a NOR gate, so the first three gates taken together constitute a NOR gate. Inverting its output turns the whole circuit into an OR gate.

PHYSICS

Paper 0625/23
Multiple Choice (Extended)

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

General comments

Many of the questions were answered correctly by the majority of candidates.

Comments on specific questions

Question 2

A number of candidates chose **D**. This was probably based on it being the lightest of the balls.

Question 3

A number of weaker candidates calculated the uphill speed and the downhill speed and took the average of the two calculations. Rather, the average speed is the total distance travelled (600 m) divided by the total time taken (75 s).

Question 8

Although stronger candidates answered this correctly, all of the other options were chosen by a significant number of candidates.

Question 9

Many candidates found this question challenging and only the strongest answered correctly.

Question 11

A large number of candidates forgot to include the gravitational field strength in their calculation.

Question 12

Many candidates had difficulty with this question, and all opinions were popular. Stronger candidates knew the formula for pressure and were careful about unit conversions.

Question 13

A number of candidates were unaware of the equation $p = \rho gh$, even though it is explicitly required by the syllabus.

Question 17

A significant number of candidates chose option **B,** but stronger candidates answered correctly.

Question 20

A significant number of candidates selected option **B** despite the lack of meaning of ‘conductor of radiation’.

Question 21

Although stronger candidates answered correctly, many other candidates chose option **A.**

Question 22

A number of candidates forgot to take the sines of the angles.

Question 24

A number of weaker candidates chose option **C**. They only needed to continue the two rays on the question paper to discover their error.

Question 27

Candidates were not expected to know any of the relative velocities, but they should know that sound travels considerably faster in solids than in gases or liquids.

Question 30

A large number of candidates believed that positive ions can move around in a metal. It is only the electrons that do the moving.

Question 31

With the switch closed, the voltmeter is simultaneously measuring the p.d. across the resistor and the e.m.f. of the cell.

Question 35

Stronger candidates were able to apply $N_p / N_s = V_p / V_s$, but not, apparently, $I_pV_p = I_sV_s$.

PHYSICS

Paper 0625/31
Theory (Core)

Key messages

Some candidates are unclear about what does or does not count as a significant figure. Centres should encourage candidates not to round to 1 significant figure and could set practice exercises on this area.

Some of the candidates' handwriting made it difficult to distinguish what they were writing. There were issues differentiating between 1's and 7's, 4's and 7's, 6's and 0's, 9's and 0's, 9's and 4's, 7's and 9's. Centres should encourage candidates to ensure that working and answers to numerical questions are as clear as possible.

General comments

The majority of candidates were well prepared for this exam. The majority were able to apply their knowledge and physics understanding to the questions set and were able to produce correct responses.

Candidates should be careful to use precise language as many frequently stated a property had changed but failed to state how it had changed i.e. increased/decreased.

Almost all candidates attempted all of the items and appeared to have no difficulty in completing the paper in the time allowed.

Comments on specific questions

Question 1

(a) (i) A large majority of candidates recognised that the graph shows constant speed. The most common errors were to state either "constant" or "constant motion" which could not be credited. A very small number of candidates answered that the car was stationary.

(ii) Almost all candidates stated that the graph showed (constant) deceleration or that the car was slowing. A small number answered incorrectly that the car has decreasing acceleration.

(iii) The majority of candidates correctly calculated the distance travelled as the area under the speed-time graph between 50 s and 90 s as 120 m. Candidates showed good understanding that distance travelled is the area under the graph and knew how to find this. The most common errors involved forgetting to halve and so giving 240 m as the answer or involved powers of 10, for instance using a time of 4 s rather than 40 s.

(b) (i) This question was answered well by almost all candidates. Weaker candidates inverted the equation and so divided the time by the distance.

(ii) Most candidates drew a horizontal line that stretched for an appropriate time at the appropriate part of the graph. Common errors included drawing a line as a continuation of the 6 m / s line or one that was too short or at the wrong speed. Some candidates ignored the instruction to draw the line on the existing axes and wasted time drawing their own axes. If the drawing was accurate these answers were credited.

Question 2

(a) (i) The majority of candidates calculated the correct answer of 0.12 (N). The most common error involved not converting to kilograms, which led to an answer of 120 (N). A less common error was to divide by *g* rather than multiply by it. This was incorrect science and so was not credited.

(ii) The majority of candidates calculated the correct answer of 14 g / cm^3. Weaker candidates inverted the equation and so divided the volume by the mass or simply multiplied the two values.

(b) (i) (ii) The correct boxes were ticked by the majority of candidates. The most common error in **(ii)** was to indicate that density increases rather than decreases.

Question 3

(a) The vast majority of candidates calculated the correct moment. The most common errors were to multiply 404 by 1.6 or 404 × (1.2 + 1.6) or to divide the force by distance.

(b) Again, most candidates correctly equated moments and calculated the force to be about 300 (N). The most common error was to either divide 404 by 1.6 or to multiply 404 by 1.6.

Question 4

(a) Stronger candidates gave their answer in a well-ordered sequence, stating that the coal is burnt to heat water which becomes steam which drives a turbine, causing a generator to turn giving electricity. There were many candidates who answered in such a way. Weaker candidates often missed out one or two stages or compressed separate stages into one process. It was not unusual to see that the coal was burnt and the gases from it drive the turbine, or that the turbine was turned which produced electricity, or that water in the coal was heated, or that the heated coal drove a generator.

(b) Many candidates found this item challenging. Stronger candidates stated that it meant that only a small fraction of the input energy became useful output energy or that large amounts of energy were wasted, showed good understanding of the concept. Weaker candidates clearly knew what efficiency meant but missed out the need for the fact that <u>much</u> energy is wasted. The weakest candidates gave answers such as “it does not work very well” or “it is renewable” and clearly did not understand the scientific meaning of efficiency.

(c) This was answered well by the majority of candidates, with most candidates gaining at least partial credit. The most common creditworthy answers were “non-renewable”, “contributes to global warming/production of carbon dioxide” and “acid rain”. Weaker candidates simply stated “pollution” or “harms the environment” and these were not considered precise enough for credit.

Question 5

(a) (i) The vast majority of candidates gained full credit. Common errors included giving 32 or 240 for the force and a very small number of candidates stated “east” without indicating which direction they thought was east.

(ii) The majority of candidates answered this correctly, giving two equal values of the force. A common error was to put two zeroes.

(b) This was another question that was very well answered and most candidates gained full credit by calculating the pressure as 125 (N / cm^2). A common error was to forget that the suitcase had two wheels and so these candidates gave 250 (N / cm^2) as the answer. Weaker candidates multiplied the force by the area.

Question 6

(a) Most candidates knew that the motion was Brownian motion. Most of those who did not give the name realised that the motion was random. The most common error was to state that the term used was diffusion.

(b) Stronger candidates realised that the haphazard motion of the pollen grains was a result of (invisible) air molecules bombarding the pollen grains. Weaker candidates thought that the motion was a result of pollen grains colliding with other pollen grains.

Question 7

(a) This item was usually answered correctly and full credit was frequently awarded. Common errors included giving white, black and pink in their list of colours (or giving both purple and violet) and so not giving the six correct colours that were required. The majority of candidates put the colours in the correct order but a small minority reversed the order and a few gave the colours in no particular order.

(b)(i)(ii) A large majority of candidates gave refraction and dispersion in the correct order. A common error was to give them in the reverse order. Other errors included giving reflection or rarefaction for refraction. Some candidates gave diffraction, spreading, spectrum, colours for dispersion.

(c) The majority of candidates gave at least one of these correctly but there was a considerable amount of confusion about the electromagnetic waves used in tv remote controllers.

Question 8

(a) (i) Most candidates answered this correctly. The most common errors were frequency and wavelength.

(ii) Fewer candidates gained credit for this question. The most common error was wavelength.

(b) (i) Some candidates found this item challenging. Most gave the correct answer of 160 m. The most common error was 80 but a few candidates attempted to calculate the speed here and gave their answer as the distance.

(ii) Most candidates who did not give 285.7 gave 142.8 as their answer (sometimes because of the incorrect use of 80 m as the distance, sometimes as an error carried forward from an incorrect distance in **(i)**). A very small number multiplied a distance by 0.56 showing a fundamental misunderstanding.

(iii) Many candidates gave valid suggestions for improvement of the experiment. Most who gained credit suggested standing further from the wall, both standing the same distance from the wall or repeating and taking an average. A common mistake was not stating the essential need to average the repeated results.

Question 9

(a) (i) The majority of candidates correctly gave plastic and wood as their answer. The most common errors were giving only one of them or adding aluminium and/or iron.

(ii) The vast majority of candidates correctly gave iron as their answer with only a few adding aluminium to the list.

(b) The vast majority of candidates correctly identified all three poles. A few reversed the poles on the right-hand magnet and a very small number used P instead of S.

(c) The majority of candidates correctly stated that the electromagnet can be switched off and/or on or could be magnetised/demagnetised easily. Common answers that did not score included "that it could be magnetised", "that it was strong(er)".

(d) Most candidates correctly identified the property giving the strongest electromagnet in each column. The most common error was to choose 20 mA instead of 3.0 A in the third column.

Question 10

(a)(i)(ii) The vast majority of candidates correctly evaluated the combined resistance in **(i)** and slightly fewer evaluated the current in ammeter Y in **(ii)**.

(b) Most candidates gained partial credit for stating that the current in ammeter X would increase. Only a minority stated that the resistance decreases and the current increases. Only stronger candidates scored full credit.

(c) This was often answered well with a correct evaluation giving the resistance of the lamp as 15 (Ω). Weaker candidates inverted the equation and so divided the current by the voltage or simply multiplied the two values.

Question 11

(a) The majority of candidates correctly identified the type of voltage in the coil as alternating.

(b) The majority of candidates correctly identified two ways of increasing the induced voltage. The most common correct answers included “increase turns”, “use a stronger magnet” or “increase speed of magnet”. The most common error was to suggest increasing the current.

Question 12

(a) (i) The majority of candidates correctly identified the two uranium isotopes. The most common error was to state Pu-238 and U-238.

(ii) The majority of candidates correctly identified Pu-238 and U-238. The most common error was to state Pu-238 and Th-34. This was probably due to confusion between nucleon number and neutron number.

(iii) The majority of candidates correctly identified Pu-238. The most common error was to state U-238.

(b) The majority of candidates correctly worked out that there are 3 half-lives and many of these used the 3 to work out the correct answer of 5.0 mg. The most common errors were to multiply 40 by 3 or to divide 40 by 3. A few considered only 2 half-lives to get the answer 10 mg.

PHYSICS

Paper 0625/32
Theory (Core)

Key messages

Some candidates are unclear about what does or does not count as a significant figure. Centres should encourage candidates not to round to 1 significant figure and could set practice exercises on this area.

Some of the candidates' handwriting made it difficult to distinguish what they were writing. There were issues differentiating between 1's and 7's, 4's and 7's, 6's and 0's, 9's and 0's, 9's and 4's, 7's and 9's. Centres should encourage candidates to ensure that working and answers to numerical questions are as clear as possible.

General comments

The majority of candidates were well prepared for this exam. The majority were able to apply their knowledge and physics understanding to the questions set and were able to produce correct responses.

Candidates should be careful to use precise language as many frequently stated a property had changed but failed to state how it had changed i.e. increased/decreased.

A number of candidates did not show any working and just gave the final answer to calculations. Candidates should be encouraged to show all the steps in their working. Credit cannot be awarded for any correct working if the final evaluation is incorrect when this is not shown.

Comments on specific questions

Question 1

(a) The majority of candidates gained full credit for this question. Weaker candidates divided 200 by 50. Only a small number of candidates explained that average thickness equals total thickness divided by number of sheets.

(b) The vast majority of candidates correctly calculated the density of iron. Weaker candidates inverted the equation and so divided 7.65 by 1377, or simply multiplied the two values together.

(c) Candidates found this item challenging, with many giving answers such as "weighing scales" or "weighing meters".

Question 2

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

(ii) The vast majority of candidates identified the constant speed as 35 m / s.

(b) Most candidates identified the car as slowing down, but few stated that the car became stationary.

(c) Most candidates correctly calculated the area under the graph to give a distance of 700 m. The most common mistakes were to either attempt to find the area under the whole graph, or to use the wrong time interval.

(d) The vast majority of candidates correctly calculated the average speed of the car as 7.5 m / s. Weaker candidates usually multiplied the two values together.

Question 3

(a) Most candidates correctly evaluated the moment of the weight of the beam as 270 N m. The most common error was giving the unit as N / m. Weaker candidates divided 150 by 1.8.

(b) Only stronger candidates were able to answer this question fully correctly.

Question 4

(a) Many candidates gained partial credit, but only the strongest candidates gained full credit. The most common errors involved failing to identify the transfers of energy and linking them to different parts of the motion.

(b) The majority of candidates identified that some of the energy had been transferred but failed to state the form to which it was transferred or failed to identify the mechanism of transfer.

Question 5

(a) (i) Very few candidates correctly identified the manometer. The most common errors were to state that it was a barometer, or simply a U-tube.

(ii) Very few candidates correctly evaluated the gas pressure as 89 (cm of mercury). The most common error was to either add or subtract 7 from the value for atmospheric pressure.

(b) The majority of candidates scored at least partial credit. Very few candidates stated that pressure = force ÷ area, but the concept that a small surface area produces a large pressure on the ground was well understood.

Question 6

(a) (i) The vast majority of candidates correctly stated that the temperature indicated on the thermometer was 32 °C.

(ii) 1. Candidates found it challenging to explain that the reason for the thin glass bulb was to enable the rapid transfer of thermal energy to the liquid in the bulb.

2. Candidates also found it difficult to explain that the narrow capillary would give a large movement of mercury along the capillary for a small change in temperature.

(b) Most candidates gained at least partial credit for this question. The most common error was failing to draw a horizontal section to represent the freezing of the liquid.

Question 7

(a) (i) The majority of candidates correctly identified X-rays, but a number could not identify ultraviolet as the other missing region.

(ii) Most candidates identified a suitable use of gamma-rays. The most common errors were either to be too vague, e.g. “medical uses”, or to describe the use of X-rays in hospitals.

(iii) Very few candidates gained full credit. The majority of candidates thought that gamma-rays would travel faster than radio waves in a vacuum, with explanations such as “they have a shorter wavelength”.

(b) (i) The vast majority of candidates answered this well but some could only be awarded partial credit as answers were not precise enough.

(ii) Very few candidates stated that frequency was equal to the number of waves/pulses per second. Only stronger candidates gained full credit here.

Question 8

(a) (i) The majority of candidates were able to draw a correct normal at X.

(ii) Many candidates found this question difficult, with only a minority correctly labelling the angle of refraction.

(iii) The majority of candidates identified a correct piece of equipment. Weaker candidates gave answers such as "a ray of red light", which failed to score.

(b) Many candidates found this question challenging. The majority of candidates drew a ray of red light being refracted into the air. Many of those who drew a reflected ray failed to do so with adequate precision to score full credit.

Question 9

(a) (i) The majority of candidates identified the particles as electrons. Common errors included "protons" or just "electricity".

(ii) The majority of candidates identified the variable resistor. The most common error was to omit "variable".

(iii) The majority of candidates correctly evaluated the resistance of the LDR as 110 Ω. Weaker candidates either inverted the equation or had a power of 10 error.

(b) Many candidates gained credit for stating the current increased but failed to link this to a decrease in the resistance of the LDR.

Question 10

(a) (i) This topic was well understood, with the vast majority of candidates scoring at least partial credit. Weaker candidates gave suggestions such as "increasing the length of the coil", or "changing the resistance of the coil".

(ii) Very few candidates linked the change in direction of rotation of the coil to reversing the direction of current in the coil.

(b) Almost all candidates gained full credit for this question.

Question 11

(a) The majority of candidates were awarded partial credit for this question. The most common error was to state that *A* is the neutron number rather than the nucleon number.

(b) (i) Most candidates were also awarded partial credit for this question. The most common error was failing to link the halving of the activity of the radioactive nuclide to its half-life.

(ii) Many candidates gained at least partial credit here. The most common error was to divide the change in activity by 10, and then use 6000 in their estimation.

PHYSICS

Paper 0625/33
Theory (Core)

There were too few candidates for a meaningful report to be produced.

PHYSICS

Paper 0625/41
Theory (Extended)

Key messages

- Candidates should ensure they take note of the command word used and answer the question to provide the information required.
- Candidates are reminded to consider the number of marks available for each question as well as the space available for their answer. This should be used as a guide but should not dictate the length of a response. Where a number of lines are given for a response, a one-word answer is unlikely to be sufficient.

General comments

Candidates need to be conversant with the whole extended syllabus in preparation for this paper and many stronger candidates were. To be sure of producing answers that are accurate and detailed, candidates need to have understood all that is included in the syllabus.

Some candidates demonstrated errors which were due to the misuse of a calculator. Candidates need to be familiar with their own calculator and, in particular, how to enter a number in standard form. A common source of inaccuracy was to enter a number that was ten times larger than the number given in a question in standard form.

Comments on specific questions

Question 1

(a) (i) Most candidates understood what was meant by the term acceleration and how it can be calculated from a graph. The single most significant source of inaccuracy was to calculate a value for an average deceleration for either the first 3.0 s or the entire 6.0 s rather than for the deceleration immediately after opening the parachute. This often produced an answer that was not within the acceptable range.

(ii) Many candidates used the deceleration obtained in **(i)** to calculate the resultant force acting on the parachutist but only a very small minority realised that the air resistance also had to oppose the weight of the parachutist. Full credit was rarely awarded although partial credit was quite commonly obtained.

(b) Many candidates stated that the parachutist ultimately reaches terminal velocity when the resultant force becomes equal to zero but fewer candidates made one of the other two points that relate to the forces acting before terminal velocity is reached. A small number of candidates supplied explanations that would explain how a parachutist who starts with zero velocity downwards accelerates until a terminal velocity is reached before opening the parachute.

(c) Stronger candidates made relevant points, but very few answered the question as it had been set. More candidates repeated points that had already been made in **(b)**.

Question 2

(a) (i) Many answers related to the momentum change experienced by the trolley and the correct answer was often given. A common error was the use of the mass of the ball rather than that of the trolley and candidates who tried to use the combined mass of the ball and trolley did not always convert the mass of the ball in grams to a mass in kilograms correctly. The unit given for impulse was sometimes inaccurate. In addition to the acceptable units, kg / m / s, kg m / s^{-1} and N / s were sometimes given.

(ii) Although the final answer was often given correctly, the use of either the mass of the trolley or a mass in units that did not match those of the number in the answer often led to incorrect answers.

(b) Many candidates obtained credit for an accurate description of the energy transfer that occurs as the trolley slows. However, fewer candidates were able to describe what was happening in terms of work done. Some candidates simply omitted any reference to work done whilst others just defined work done and made no further reference to it in the response.

Question 3

(a) Many candidates referred to the small intermolecular distances in liquids and others to the strength of the repulsive forces. For full credit, both points needed to be made. The attractive forces are not important when the difficulty of compressing liquids is being explained and some answers that would otherwise have been completely correct were incomplete by referring only to attractive forces.

(b) (i) Credit was often awarded for the use of the equation $P = F / A$ and for a calculation leading to 5.5×10^5 (Pa) but only a few candidates went on to add on the pressure of the air. Many candidates ignored it and others subtracted it.

(ii) Many candidates stated that the increase in depth leads to an increase in pressure in the oil and some candidates quoted the relevant expression $P = h\rho g$. Fewer candidates then explained that the pump needs to exert an increasing pressure on the oil in order to overcome this increase in pressure.

(iii) The statement that these two forces are equal was not enough for any credit. It needed to be clear that the forces cancelled or that there is no resultant force. Very few candidates made any reference to the weight of the piston or to friction within the mechanism.

Question 4

(a) There were two approaches here. Candidates could simply compare the thermal conduction properties of aluminium and plastic or could explain why, in terms of the use of a saucepan, such properties are an advantage. A very large number of candidates were awarded credit for this part. However, some candidates only referred to the plastic or the handle.

(b) (i) Many candidates were able to state that the increase in internal energy corresponded to an increase in either the kinetic or potential energy of the molecules.

(ii) The question indicated that both the atomic lattice and the electrons need to be referred to in the answer. Many answers referred only to electrons or less commonly only to the lattice. Some candidates described the mechanism by which the atomic lattice transfers thermal energy but substituted the word electron for atom or molecule. This was not awarded credit.

(iii) An approach that was frequently observed in this part was to give an explanation that would have been more appropriate for explaining evaporation or to describe the increase in temperature that takes place before the boiling point is reached. Few candidates made any mention of the increase in the potential energy of the molecules that occurs as they leave the boiling water.

(iv) There were many good answers here and full credit was often awarded. The equation that defines specific heat capacity was often quoted but it was not always used. When it was quoted as $Q = mct$, some candidates substituted the time of 300 s for t. Candidates should be encouraged to use the symbols that appear in the syllabus where t is used for time and T for temperature.

Question 5

(a) There were many answers here that showed some understanding of the thermal expansion of a liquid and partial credit was often awarded. There were also answers that seemed to describe the change in volume that takes place when a liquid becomes a gas. Answers that referred to the expansion of individual molecules were not awarded full credit but, in some cases, credit was awarded for other comments made.

(b) Only stronger candidates answered this question well. Some candidates offered partial explanations in terms of the intermolecular forces but a less successful approach was based on the larger intermolecular spacings in liquids.

(c) (i)(ii) Few answers suggested that either sensitivity or range were quantities that were understood. Some candidates suggested that the sensitivity of a thermometer referred to the speed with which it reached the final temperature reading and the most common answer to **(ii)** was that the range of both thermometers and the diameter of the tubes would be equal.

(d) (i) This question required reference to a problem and this was very commonly not stated. When the example chosen was the thermal expansion of railway tracks it was necessary to state the consequent problem. Candidates who referred to the buckling of the track in some way were awarded credit.

(ii) Possible solutions to the problem mentioned in the previous part were often seen but there were few explanations.

Question 6

(a) This question was very often awarded full credit. However, there were some answers that labelled one compression and one rarefaction and others where the compressions were poorly marked.

(b) There were many good answers here and the wave equation was well known and was usually correctly rearranged. The most common error was for the wavelength to be measured inaccurately or for the wavelength to be taken as the full width of the diagram. Candidates that did not show any working out or any other intermediate detail were rarely awarded any credit.

(c) There was a variety of ways in which candidates could obtain credit in this question but few answers were complete. There were many candidates who realised that increasing the frequency would lead to a reduced wavelength.

Question 7

(a) (i) Almost all candidates sketched a sinusoidal wave of some sort and only a few were so poorly drawn that little or no credit was obtained. Some diagrams did not show exactly two cycles of the alternating electromotive force and only a few candidates labelled the *y*-axis and the *x*-axis.

(ii) Although most candidates who attempted this part marked a P in a correct position, many candidates did not give an answer at all.

(iii) Many candidates were able to give one correct change and often an increased voltage was mentioned. Fewer candidates were able to give a second change that was different and there were candidates who gave answers that treated the two terminals X and Y differently.

(b) A few candidates knew precisely how a transformer operates and gave excellent answers that explained in detail what happens in a transformer when the primary coil is connected to the output of a generator. Other candidates gave rather confused answers which referred to what was happening inside the generator or what happens inside a d.c. motor. Some candidates stated that a transformer turns an a.c. into a d.c.

(c) There were many good answers here and full credit was often awarded. However, some candidates believed that stepping up the transmission voltage reduced the resistance of the cables.

Question 8

(a) Most candidates were able to draw in the symbol for a thermistor. A few candidates gave the symbol for a different circuit component but very few candidates omitted this part.

(b) This was usually answered correctly. Candidates who were not awarded full credit often tried a more involved calculation, rather than the simple division that was needed. An answer of 96 V was given by several candidates.

(c) (i) The correct answer was often reached and full credit was awarded. However, the most common answer was 533 Ω. This nearly always came from the assumption that the potential difference across the 800 Ω resistor was 12 V.

(ii) Few candidates explained how their conclusion was reached. The simple comment that the voltage increase revealed an increase in the resistance of the thermistor was not sufficient as it did not consider that the current in the circuit must have decreased. The conclusions themselves included all possible combinations of an increased and decreased resistance revealing an increased or a decreased temperature.

Question 9

(a) The nuclide notation symbols were very frequently correct with a small minority of candidates writing the numbers on the right of the Hs or reversing the nucleon and proton numbers.

(b) (i) The two main causes of error were candidates who explained nuclear fusion by using a word such as “fuse” or “fusing” or who made no reference to the involvement of nuclei. A small number of candidates stated what is meant by nuclear fission.

(ii) Only a few candidates were awarded full credit in this part. Many candidates gave the nuclide notations for hydrogen-2 and hydrogen-3 as the products as well as the nuclear reactants.

(c) There were many candidates who obtained at least partial credit here but few gained full credit. A common incorrect answer was that wave energy does not have a solar origin. The term “tidal wave” is a common term for a tsunami rather than an energy source.

PHYSICS

Paper 0625/42
Theory (Extended)

Key messages

- It is essential that candidates show their working and write down the equations.
- The Appendix to the Syllabus lists the symbols that should be used in candidates' responses. As has been observed for some years, Q is not the correct symbol in the Syllabus for thermal energy and candidates should not use this.
- All but the very strongest candidates would benefit from more practice in applying their knowledge in unfamiliar situations and in answering "show that" questions. This would deepen candidates' understanding and improve their performance in the examination. Many candidates found it challenging to apply their knowledge of physics to a new situation.

General comments

Many candidates were well prepared for this paper. A small but significant minority of candidates found the subject matter and level of some questions so difficult that these questions were inaccessible to them and would have been better entered for the Core paper. The vast majority of candidates indicated by their knowledge and skills that they were correctly entered for this Extended Theory paper.

Equations were generally well known but the use of equations and the quantities represented were not always understood. There were frequent examples where candidates substituted numbers from the question in the wrong place in equations.

Unless otherwise stated, it is expected that candidates should round their final answer to 2 or 3 significant figures. However, intermediate values should not be rounded or truncated as this frequently leads to an inaccurate final answer.

Often candidates did not read the questions carefully enough and wrote answers to the question they thought was being asked. This often occurred in **Question 2(c)** where many answers had one or more horizontal forces, **Question 6(a)** where candidates drew a ray of blue light approaching the prism on a different path from the ray of green light and **Question 8(b)(ii)** where no reference was made to the moment.

The use of units by most candidates was generally good with occasional lapses, especially in **Question 6(b)**.

Comments on specific questions

Question 1

(a) This was correctly answered by most candidates.

(b) **(i)** This was correctly answered by most candidates.

(ii) Only stronger candidates correctly linked a reduction of volume to an increase of density. Weaker candidates often made vague statements about how the pressure affected the movement of the balloon. Sometimes they suggested that the air pressure outside the balloon would push the balloon upwards or downwards.

(c) **(i)** There was a wide range of quality of the graphs drawn. Nearly all started at the origin and many finished horizontal. However, only stronger candidates drew a curve with a smoothly reducing gradient from the origin to the horizontal portion.

(ii) Most candidates answered this well. Weaker candidates often reversed the two values or had them both the same.

Question 2

(a) There was a lack of precision in describing the distance in many answers. Candidates needed to write that it is perpendicular distance from the pivot.

(b) Stronger candidates accurately worked out this moments question. However, many others used the mass of 50 kg instead of the force of 500 N.

(c) Again, stronger candidates gained full credit for this question. But others gave vague answers such as diagrams without clear labels or descriptions leaving out essential detail. A few drew a balance beam on a pivot but then indicated a force on each side of the pivot producing moments in the same direction or one or more horizontal force. It was important to indicate the forces acting, either in the diagram or in the text, and not just show masses because the question was about moments which require forces. Other candidates relied on the diagram in **(b)** attempting to redraw this or something similar but often with horizontal forces, despite the question explicitly mentioning vertical forces. Only the very strongest candidates stated the readings that were needed or explained how to find the moment to show the conditions for equilibrium.

Question 3

(a) This was generally well answered with many candidates gaining full credit. Candidates should be aware that in a "show that" question it is essential that every step in the working is written down to show the full argument and not doing this will limit the credit that can be awarded. A common error was the circular argument in which 15 was divided by 17 to get the time and this was then used in the equation speed = distance ÷ time.

(b) The correct route through this question, with force equal to rate of change of momentum, was used by most stronger candidates who gained full credit. The route through $F = ma$ was not correct in this instance.

Question 4

(a) (i) This was well answered by most candidates. The answer of Brownian motion did not describe the movement so did not gain credit.

(ii) Most candidates wrote that there were collisions between smoke particles and air molecules but many then did not give further appropriate detail.

(b) (i) Nearly all candidates made the correct statement that cooling would occur. Many went on to correctly say that thermal energy was required but few made the link to say that this thermal energy was taken from the skin or the patient. Stronger candidates were clear about the store or type of energy being transferred, which was thermal in this case.

(ii) This question was generally answered well.

Question 5

(a) Paper, or the holder, was often credited with being the insulator. Only a minority of candidates identified air as the main insulator. Many candidates credited air with reducing convection or directing the heat away from the holder or as having an ability to absorb thermal energy. Most candidates realised that the reduction in thermal conduction would result in the surface of the holder having a lower temperature but did not always explain this clearly.

(b) Because this question asked for a more effective action, answers needed to refer to something covering the surface of the liquid. Adding another layer of insulation around the sides is not going to make an effective difference whilst there is still evaporation and convection occurring at the surface. Some candidates gave very vague answers, talking about stopping the heat escaping for instance. Candidates needed to use appropriate scientific terminology when explaining ideas about cooling.

There were a significant number of candidates who misunderstood the question and talked about making the drink cool faster using wind for example.

(c) The vast majority of candidates answered correctly.

Question 6

(a) Many candidates gained full credit. The most common errors included drawing the blue ray as being refracted less than the green ray at the first face or using a different path to the incident ray of green light for their ray of blue light. These candidates had not read the question carefully as it stated that the ray of blue light is on the same path as the ray of green light.

(b) The majority of candidates gained full credit. The most common errors were using an incorrect arrangement of the equation or not being able to recall the velocity of light. Some candidates omitted the unit or gave an incorrect unit. It may be dimensionally equivalent but s^{-1} is not the same as Hz and it is not the unit of frequency to be used. (see Syllabus Appendix).

Question 7

(a) Most candidates knew the direction of the field but many did not draw three lines in the gap between the magnets. The most common error was in drawing field lines from the side of one magnet to the side of the other.

(b) (i) Only a few candidates showed an arrow pointing towards the S pole. Sometimes, no direction was given and often the arrow pointed away from both magnets. Even more often, a compass needle was drawn without indicating which end was the N pole.

(ii) Only stronger candidates answered this well. Some others gained partial credit saying that unlike poles attract but fewer were able to use the idea of the needle aligning with the field. Vague answers included descriptions of the field going from N to S with no connection to the needle itself. There were a few answers which confused magnetic field with electric field or referred to the direction the compass needle would point in the Earth's magnetic field.

(c) Most candidates knew how to demagnetise a magnet. Hammering and heating were popular answers, but candidates who gave these answers often did not go on to gain further credit for good detail. Putting the magnet in a coil with a.c., and removing the magnet, was the most common correct answer but many of those who attempted it forgot the need for a coil or stated that the a.c. should pass through the magnet.

Question 8

(a) There were a significant number of answers where candidates had added more than one alpha or gamma symbol in the table, sometimes filling up all the boxes.

(i) This was correctly answered by most candidates.

(ii) A considerable number of candidates gave an incorrect answer for α. A typical error was to put the α symbol in Box 2.

(b) (i) Many candidates gave the correct statement that the coil rotated clockwise. However, explanations were often too vague. For example, the majority of arrows drawn on the diagram were unlabelled so it was not possible to know what they represented and were unable to be credited.

(ii) Many stronger candidates correctly answered that there was no moment on the coil. However, many other candidates stated that the coil continued to rotate. This was not asked in the question so could gain no credit.

(iii) Many candidates correctly stated that the current in the coil reversed but made no correct statement about the forces on the coil.

Question 9

(a) Almost all candidates gave the correct directions for the current and flow of electrons. A few gave both in the reverse direction but still gained partial credit. The most common error was drawing unlabelled arrows that could not be given credit.

(b) Many candidates gave the correct answer. Many who did not, gained partial credit from correctly quoting $Q = It$. The most common error for those who gave $Q = It$, but then did not go on to get the correct answer was in not substituting the numbers correctly and consequently dividing the charge on the electron by the current.

Many candidates used incorrect symbols such as *C* for charge or for current which could not be credited.

Question 10

(a) This was answered well with many candidates gaining full credit. However, there were a great number who struggled with converting from mA to A. This resulted in a range of answers with a power of ten error.

(b) Most answers to this question were clear, succinct and logically formed. The variation of resistance with temperature of the thermistor was clearly known and the effect on the potential divider was very well understood. However, many candidates did not read the question and spent too long explaining the situation at low temperatures. It was the change from low to high that was required. Candidates were often left with little space to write the explanation for high temperature or made vague comments such as "vice versa".

In the circuit there were several components all of which had resistance, current and voltage. Candidates needed to specifically mention which component they were referring to. Saying, for example, that resistance increases without qualification was too vague. It really gave no meaningful information and so gained no credit.

(c) Many candidates did not know the correct name for this component. Answers such as "temperature dependent resistors" were not credited.

Question 11

(a) (i) Only stronger candidates answered this question correctly. Problems occurred either in forgetting to adjust for background before halving the count rate or forgetting to add the background back after halving in order to read the correct time off the graph. Common incorrect answers were 2.8 minutes and 3.2 minutes. Some candidates attempted to calculate how many times the count rate had halved in 7.5 minutes but this was not usually successful, due to errors in adjusting for background.

(ii) Good attempts were made to calculate the count rate at 9.6 minutes, but as with **(i)** many candidates forgot to add on background to find the detected count rate.

(b) The range of answers here showed good preparation by candidates. Responses often included two or three extra details in the explanation. However, candidates should take care to link their explanation to the question that is asked. A statement that alpha-particles cannot pass through paper did not, on its own, say anything about whether or not they will pass through the plastic box.

PHYSICS

Paper 0625/43
Theory (Extended)

Key messages

- Candidates are advised to read questions carefully and to answer the question as stated and not another possible question on the same topic.
- Diagrams should be carefully, neatly and accurately drawn to ensure maximum credit can be gained. If a question suggests that the candidate may wish to draw a diagram to explain their answer, candidates are advised to do that.
- Candidates are advised to be careful to always use the correct unit for the question and to look out for situations where there are different powers of ten, e.g. V and kV in **Question 9(a)**.

General comments

Questions **3(a)**, **3(b)**, **4(b)(i)**, **4(b)(ii)**, **5(a)(ii)**, all of **Question 7**, **9(c)**, **10(a)(i)** proved more challenging on this paper for many candidates while **Questions 3(c)(i)**, **8(c)(i)** and **10(a)(i)** were answered well by most candidates.

Several questions or part questions were omitted by some candidates. This did not seem to be due to a lack of time to complete the paper. There may be some evidence that some parts of the syllabus were less well known than others. There was some evidence that definitions were not well known.

Comments on specific questions

Question 1

(a) Stronger candidates wrote down the equation $F = kx$ and then correctly rearranged it. Some candidates misremembered the equation and others used incorrect values for F or x. Some candidates did not gain full credit as they did not include a unit or gave a wrong unit.

(b) Stronger candidates stated that initially the extension was proportional to the load and then stated that this was only true up to the limit of proportionality. Weaker candidates confused the limit of proportionality with the elastic limit and referred to the spring not returning to its original length.

(c) Many candidates drew a straight line from the origin. Fewer candidates drew a correct upward slope of increasing gradient beyond the limit of proportionality. Candidates should be advised to make sure that they use labels when asked to do so. The label L for the limit of proportionality was required in this answer.

(d) Stronger candidates made clear statements about energy transfer by correctly identifying the type of energy store that was being transferred to another energy store. Vague answers which only stated types of energy and no transfer could not be awarded any credit. Candidates need to be aware that they should check their answers for contradictions.

Question 2

(a) (i) Most candidates correctly stated that the area of contact of the books with the shelf affected the pressure exerted. Excellent answers stated the equation relating pressure to force and area or stated that pressure was inversely proportional to area and then went on to state that the force exerted by the groups of books was the same. Less well-expressed answers made no reference to the forces being the same for both groups.

(ii) Some candidates correctly calculated the area of one or six books in contact with the shelf and the corresponding force exerted by one or six books and then calculated pressure with an appropriate unit. Candidates needed to check that they had used a correct unit, e.g. to calculate pressure in Pa, an area in m^2 was required. Weaker candidates used incorrect dimensions to find the area or used mass instead of force.

(b) The equation $p = \rho gh$ was recalled correctly by most candidates. Those candidates who gained full credit did so because they realised that they needed to subtract atmospheric pressure from the total pressure to find the pressure due to the water. A common mistake was to add the atmospheric pressure instead of subtracting it.

Question 3

(a) Candidates needed to recognise that thinking time was constant. This did not seem to be fully understood.

(b) Candidates who realised that kinetic energy needed to be transferred to stop the car and correctly stated the equation kinetic energy = $\frac{1}{2}mv^2$ were awarded partial credit. To gain full credit they needed to then state that the work done to lose kinetic energy was Fd or that it was proportional to the velocity before braking.

(c) (i) Most candidates calculated the time correctly. A few were unable to rearrange $v = d / t$.

(ii) Candidates who realised that they could use $F = ma$ were able to gain at least partial credit. Candidates needed to ensure that they used the relevant numerical values given in the question. Some candidates just chose values given without considering whether they were values for time or distance or velocity. A common misconception was that the answer could be obtained by calculating the weight of the car.

Question 4

(a) (i) The definition of specific latent heat of fusion was not easily recalled by many candidates. Some could recall that it was the energy transferred when a substance was changing state. The strongest candidates stated the specific change of state and said that it was for unit mass of a substance. There was some confusion between specific latent heat and specific heat capacity.

(ii) There were some excellent answers showing that candidates understood that while there was ice, energy would be transferred to melt the ice instead of increasing the temperature of the water.

(b) (i) Candidates needed to show that they understood that it was faster moving molecules that escaped from the sweat, that this caused a decrease in overall temperature of the sweat and that resulted in a transfer of thermal energy from the person to the liquid. The strongest candidates included all three of these points. Weaker answers made no reference to molecules. Candidates are advised to take careful note of the wording of the question to ensure that they answer it in the terms that are required.

(ii) Vague answers of faster evaporation did not explain why this occurred. Stronger candidates referred to the wind blowing the molecules away or not allowing them to re-enter the liquid.

Question 5

(a) (i) Candidates are advised to draw diagrams carefully to show that they understand the physics relating to what they are asked to draw. In this case, it was semi circles centred on the gap and with the wavelength remaining the same as the incident waves.

(ii) Very few candidates made use of the information in the question which stated that the gap was much wider. They realised that there would be less diffraction. The presence of a much wider gap would mean very little diffraction so they were required to state that they would pass through the gap remaining as straight waves.

(b) The equation $v = f\lambda$ was well known and usually rearranged correctly. Candidates are advised to first state the equation in its usual form before rearranging it or substituting numerical values. The unit given was usually correct.

Question 6

(a) The positions of both focal points were usually marked accurately. It was important that candidates marked both points clearly.

(b) Most candidates drew the ray that passes through the centre of the lens correctly. Stronger candidates drew all three rays and the image carefully, using a ruler.

(c) Candidates who did not draw an accurate diagram in **(b)** often produced unclear answers about the properties of the image formed.

(d) (i) Stronger candidates correctly identified that the image formed by a magnifying glass was a virtual image or that it was not inverted.

(ii) Candidates who had been unable to answer other parts of this question correctly were able to mark a suitable position for the object to be placed so that the lens was used as a magnifying glass.

Question 7

(a) The definition of electromotive force (e.m.f.) was not well known. Stronger candidates understood that e.m.f. was energy supplied and not a force. Other weaker candidates referred to the total voltage of the circuit. A few candidates knew that it was the energy supplied to drive unit charge round a complete circuit.

(b) (i) Most candidates realised that they would need to use the equation $R = V/I$ and remembered it correctly. Some understood that the current in PQ would be twice that in one of the lamps and the strongest candidates could identify that the p.d. across PQ could be calculated by subtracting the p.d. across the lamps from the voltage across the cell.

(ii) Candidates who gave answers stating that resistance is proportional to length and resistance is inversely proportional to area were awarded partial credit for these statements. Candidates who showed multiplication and/or division by 2 were not awarded credit here. To calculate the correct answer, candidates needed to recognise that when the diameter was twice its original value, the cross sectional of the wire was increased by a factor of 4. This did not seem to be understood by most candidates.

Question 8

(a) Stronger candidates showed or clearly stated the difference between analogue and digital signals. This was most easily shown with the help of a diagram. Candidates are advised that if a question states that they may draw a diagram to help explain their answer then it is advisable, though not essential, to draw a diagram.

(b) Careful drawing of the correct symbol with 2 clear inputs and 1 output was required here.

(c) (i) This was usually correctly answered and candidates could interpret truth tables accurately.

(ii) This was usually correctly answered. A few candidates used various numbers or letters instead of 1s and 0s.

Question 9

(a) Candidates who used the correct equation here usually gained full credit. A few confused input and output. Some answers incurred a power of ten error due to not correctly converting kV to V.

(b) Stronger candidates drew careful diagrams with the iron core, copper coils and primary and secondary coils labelled. Candidates needed to clearly indicate which was the primary and which was the secondary coil to gain credit for fewer turns on the secondary than on the primary.

(c) The operation of a transformer was not well understood by some candidates. References to step-down and step-up transformers and the differences in the numbers of turns, voltages and current were not relevant to this question. Good answers included a careful explanation of the need for an alternating current in the primary, stating that it is needed to provide an alternating magnetic field and hence an induced voltage.

Question 10

(a) (i) Candidates needed to understand how to work out the direction in which an alpha-particle would be deflected in a magnetic field but many did not fully understand this. There were many answers with the alpha-particles deflected in the opposite direction to the correct one. Some candidates drew the path as a straight line in a different direction or had alpha-particles continuing in a straight line for 20 or 30 mm before beginning to curve. These answers could not be credited.

(ii) Most candidates clearly showed the deflection of beta-particles in the opposite direction from alpha-particles. Fewer showed that there was a greater deflection. This was sometimes confused with beta-particles beginning to deviate after a greater distance.

(iii) The path of gamma-rays was well known.

(b) Stronger candidates stated clear safety precautions that hospital staff could take when working with gamma-ray sources. Some candidates referred to safety measures for patients or different types of radiation or safety measures in a science laboratory. These did not answer the question asked.

(c) (i) There were many correct answers. Common mistakes were writing the numbers on the right of the symbol, numbers upside down or number of neutrons used instead of number of protons.

(ii) Candidates who gave two distinct reasons relating to the type of emission and the length of the half-life gained full credit.

PHYSICS

Paper 0625/51
Practical Test

Key messages

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

General comments

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

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

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 showed evidence of undertaking regular practical work. Some candidates appeared to have learned sections from the mark schemes of past papers and written responses that were not appropriate to the questions set.

The practical nature of the examination should be kept in mind when explanations, justifications or suggested changes are required, for example in **Questions 1(e)**, **2(e)**, **3(d)** and **3(e)**.

Comments on specific questions

Question 1

(a) The majority of candidates successfully recorded the d value in cm. Some appeared to have taken the measurement from the figure instead of from their apparatus.

(b) (c) Most candidates recorded realistic t values and completed the calculations of T correctly. T^2 values were expected to be given to consistently three or consistently four significant figures. Candidates carrying out the experiment correctly obtained increasing T^2 values.

(d) 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 but some drew a dot-to-dot line whilst others drew a straight line that did not match the plots.

(e) Here candidates were expected to realise that timing errors at the beginning and end of the timing period are less significant when timing 10 oscillations. Some candidates appeared to refer to 10 separate timings of one oscillation giving an average result, not realising that a single time for 10 oscillations is the technique involved.

Question 2

(a) Most candidates recorded realistic values for current and potential difference and calculated the resistance correctly.

(b) Candidates who had rearranged the circuit correctly obtained a value for I_2 less than I_1. Correct use of the units A, V and Ω was credited here.

(c) Candidates were credited for completing the third set of readings with I_3 greater than I_1 and then for carrying out the calculation to obtain the value of R_P less than the value of R_1.

(d) Candidates were required to draw two resistors in parallel and have a complete circuit with correctly positioned ammeter and voltmeter with all the correct circuit symbols used.

(e) Candidates gained partial credit for suggesting the use of additional resistors. Some candidates realised that, in order to obtain a result with convincing validity, at least five sets of results would be required, adding a resistor each time.

Question 3

(a) Most candidates drew the normal and lines **EF** and **GH** accurately.

(b) Many candidates accurately drew the line **PQ** at 30° to the normal but some drew the line at 60° to the normal. Fewer candidates placed the pins P_1 and P_2 correctly at a distance of at least 5 cm apart.

(c) Most candidates measured the distances *a* and *b* correctly, but some did not include a correct unit (cm or mm). Calculations of *b*/*a* were usually correct, but a significant number of candidates did not realise that the ratio has no unit.

(d) A significant number of candidates incorrectly suggested carrying out the experiment in a darkened room. Successful candidates made valid suggestions such as viewing the bases of the pins.

(e) Candidates were expected to suggest at least four additional angles of incidence with a range of at least 30° and all less than 90°.

Question 4

Candidates who followed the guidance in the question were able to write concisely and addressed all the necessary points. A significant number of 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.

Candidates needed to include a stop-watch (or other timing device) for initial credit to be awarded.

A concise explanation of the method was required. Candidates should concentrate on the readings that must be taken and the essential parts 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 note that the block must be removed from the hot water and then the temperatures taken over a period of time. Candidates then needed to make it clear that the procedure was repeated with blocks made of different metals. A vague reference to repeats was not sufficient as it was not clear whether candidates were referring to using different blocks or repeating the measurements with the same block.

Candidates were expected to identify at least one variable to keep constant. The dimensions of the blocks or the starting temperature of the hot water were correct suggestions.

Many candidates drew a suitable table. They were expected to include columns for the metal of the block, temperature and time with appropriate units.

Candidates were expected to explain how to reach a conclusion. A graph of temperature against time for each metal was a suitable suggestion or an explanation of how to relate the temperature drop for each metal to the rate of cooling. 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 Test

Key messages

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

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 International to check that the change is appropriate and that candidates will not be disadvantaged. Any changes must be recorded in the supervisor's report.

General comments

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

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

The majority of candidates 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 the practical test were attempted and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly, record observations clearly and perform calculations accurately and correctly. Units were well known and were almost always included. Writing was neat and legible and ideas were expressed logically. However, many candidates seemed less able to derive conclusions backed up by evidence, or to present well thought out conclusions.

The gathering and recording of data presented few problems for any candidates. There was evidence of some candidates not having the use of a calculator.

The ability to record readings to an appropriate level of precision, usually reflecting the measuring instrument being used, or to quote a derived result to an appropriate number of significant figures, caused difficulty for many candidates. There were also many examples of candidates repeating a measurement and overwriting their first answer. Candidates should be encouraged to cross out completely and to re-write their answers so that there is no ambiguity. Some candidates had difficulty in choosing an appropriate scale to plot their graphs and in drawing a best-fit line to display their data.

Comments on specific questions

Question 1

(a) Many candidates gave a sensible estimate of the volume of water that the beaker could hold when filled to the top. Overestimates were relatively rare. Most incorrect answers were underestimates, with many candidates quoting values of 250 cm^3 or less. Occasionally, an answer within the allowed range could not be credited because the candidate was too precise and quoted the answer to the nearest cm^3, or even less.

(b) Most candidates gave clear and concise accounts of how they would use the string and ruler to determine an accurate value of the circumference of the beaker. Of those candidates who wrapped the string around the beaker multiple times, a few forgot to make a suitable division. Another acceptable method used by a much smaller percentage of candidates was to place the string across the diameter of the beaker and divide their measured length by pi. Candidates who followed the suggestion, and produced a well-drawn diagram, gained credit from the diagram alone.

(c) The height of the beaker given was usually in the accepted range of tolerance, and usually given to the nearest millimetre.

Most calculations for the external volume of the beaker were correct, but many candidates incorrectly quoted their answer to too many significant figures or rounded their final value incorrectly.

(d) The required measurements were usually all present and the mass of sand in the beaker was calculated correctly.

The density calculation was usually correct, but occasionally an incorrect unit was provided. Common incorrect units seen were cm^3/g, Pa and M / V.

Question 2

(a) Almost all candidates followed the instructions for the construction carefully and obtained full credit. A common error was to use a spacing of 8 mm instead of 8 cm between the lines **CD** and **EF**.

(b) The angle of incidence was usually accurately measured. The most common error was to draw this angle to the mirror, and not the normal. A minority of candidates did not take enough care and, although the angle was drawn from the normal, it was outside the tolerance of 1° allowed. Only a minority of candidates placed pins P_1 and P_2 at least 5.0 cm apart. In image location by the placement of pins, it is expected that pins are placed at least 5 cm apart in front of the mirror.

(c) Most candidates followed the instructions carefully and located the image. Common errors were placing pins P_3 and P_4 on the wrong side of the normal and ignoring the instructions to label the pins. Without these labels it was not possible to check that the correct distances *a* and *b* had been measured.

(d) The measurements of the lengths *a* and *b* were usually accurate to within $\pm$ 1.0 cm. Most candidates included an appropriate unit. The ratio of *a*/*b* was almost always calculated correctly. There were occasional errors in rounding of the ratio and/or in quoting the ratio to 1 significant figure.

(e) The calculation was usually correct. There were sometimes errors as although the ratio *a*/*b* is dimensionless, candidates included the unit mm or cm.

(f) Candidates were asked to compare the two values they had obtained for the ratio *a*/*b* and state whether these values could be considered to be equal. Most candidates were able to state whether or not their results supported the statement given. However, not all candidates were able to go on and give a convincing justification for their statements.

The idea of experimental tolerances, and whether two measured quantities are close enough to be considered equal was not well understood by the majority of candidates. Generally, if the values differ by 5% 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*". Between the values of 5% and 10%, either answer is acceptable provided that it is qualified by a phrase, such as "*yes, they are close enough to be considered to be equal*" or "*no, they are too far apart to be considered to be equal*".

(g) Only stronger candidates were able to suggest a practical reason as to why the results of this experiment may not be accurate, despite just having carried out the experiment. These candidates talked about the difficulty in lining up the pins, the pin thickness and the thickness of the mirror as being contributory factors. Most candidates gave generic examples of poor experimental technique, such as parallax error and not reading the ruler correctly, despite the wording of the question.

Question 3

(a) The reading and recording of the current and potential difference was done by almost all candidates. Occasionally readings were not quoted to the precision required, or the units of the quantities were missing.

The resistance of resistor R was usually calculated correctly, but some candidates just truncated the resistance value shown by their calculator and did not round the value correctly.

(b) A significant number of candidates did not follow the instruction given in the question, to disconnect the voltmeter from terminal B and reconnect it to terminal C before proceeding. This resulted in too high an initial potential difference across the various lengths of wire.

(c) There was some good graph plotting this year. Candidates nearly always chose sensible horizontal and vertical scales. However, the instruction to start both axes at the origin was not followed by some candidates. 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 them 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 was forced through the origin.

The most common sources of error were:
- missing labels and/or units on the axes
- a choice of scales which meant that the plotted points did not occupy at least half of the grid
- plots that were too large, which made it difficult to judge the accuracy of the plotted point
- dot-to-dot lines, instead of a single best-fit line.

(d) Most candidates obtained a correct value for the length of the resistance wire needed. Many of these candidates did not observe the instruction given to show their method clearly on the graph and, as a consequence, this could not be awarded credit for working.

Question 4

Many candidates produced very good diagrams of the experimental set-up they would use. A suitable means of support for the loaded spring was expected, but despite a boss, clamp and stand being given to candidates in the list of apparatus available, many diagrams showed a spring hanging in the air, with no visible means of support.

Occasionally candidates mounted the spring horizontally.

Candidates were asked to give a list of metals suitable to be made into springs and at least three different metals were required to gain credit. The three most common answers given were copper, steel and aluminium. A sizeable minority of candidates incorrectly included plastic in their list of metals.

Most candidates obtained at least partial credit for describing how they would carry out the investigation. The most common error here was to neglect to state that the initial length of the spring needed to be measured/recorded before the loads were added, in order that the extension produced by the load could be calculated. Some candidates used a range of loads on each different spring, whereas others used a single, constant load. Both methods were equally suitable, but candidates who used a range of loads found it more difficult to explain how they would reach a conclusion upon analysis of their results. Some candidates who explained the procedure correctly when using the spring made from the first metal, did not continue and say that the experiment needed to be repeated for springs made from the other metals.

Most candidates stated a suitable variable they would need to keep constant whilst investigating the effect of material upon the extension of a spring. When the length of the spring was chosen as the variable to keep constant, candidates needed to state that it is the original length, and many did not do this.

The table was usually drawn correctly. Common errors were not including units in the headings, incorrect units, e.g. weight in g and not N, or not including a column for the material of the spring/metal.

Stronger candidates obtained credit for the conclusion by using a fixed load/mass in their methods and comparing the extensions of each spring or by drawing a bar chart. If a range of loads were used, only the strongest candidates suggested plotting an extension–load graph for each metal and comparing, or comparing the extensions for the same load in each range.

PHYSICS

Paper 0625/53
Practical Test

Key messages

Candidates need to have a thorough grounding in practical work during the course. This should include discussion on the precautions that need to be taken to improve reliability. Candidates should have had significant experience in carrying out experiments themselves. Candidates should be made aware that the paper tests understanding of experimental techniques and that explanations will need to be based on data with practical rather than theoretical considerations being taken.

Direct measurements should always be taken to the necessary accuracy with calculations stated to the required number of significant figures, with the correct units and clear working shown where applicable. These techniques will be tested in this paper. The use of fractions is not allowed.

Candidates must be prepared to apply their practical knowledge to situations that could appear new to them.

Questions should be read carefully so that a full understanding of what is required from the question is clear and that appropriate answers are given.

General comments

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

- graph plotting and interpretation
- manipulating data to obtain results
- drawing conclusions
- tabulating readings
- control of variables
- dealing with possible sources of error
- understanding the concepts of results being equal within the limits of experimental accuracy choosing the most suitable apparatus.

The majority of candidates were able to demonstrate some ability and understanding of all the practical skills being tested. All parts of all tests were attempted and were successfully completed within the allotted time. Most candidates followed the instructions correctly and performed calculations to the required accuracy. It is expected that linear measurements are given to the nearest millimetre and calculated answers are stated to 2 or 3 significant figures as appropriate. Candidates seemed less able to draw conclusions from provided evidence.

Comments on specific questions

Question 1

(a) Nearly all candidates correctly measured the length of the spring to the required accuracy of ±1 mm.

(b) (i) Nearly all candidates successfully measured the stretched length of the spring to the nearest millimetre.

(ii) Most candidates calculated the correct extension from their results from **(a)** and **(b)(i)**.

(c) The majority of candidates measured the new stretched length and extension correctly. Some candidates did not show their working and/or omitted the unit.

(d) Many candidates correctly measured the stretched length and extension. They correctly used the equation to calculate the density value with most giving their answers to 2 or 3 significant figures.

(e) Only stronger candidates answered this correctly with others either looking for a complicated answer or giving answers that had no relevance to the question.

(f) Many candidates gained credit by drawing a diagram of either an eye perpendicular to the spring or a ruler parallel to the spring. Others successfully described the same precautions without a diagram.

(g) Stronger candidates recognised that this graph would be a straight line with only a few realising that to be directly proportional it would have to pass through the origin. Several candidates correctly identified that the graph would have a line with a constant positive gradient.

Question 2

(a) This was answered well with the great majority of candidates giving their answers to the required 2 decimal points.

(b) Most candidates labelled the axes correctly with the appropriate quantity and unit. Many candidates used the correct scales but some did not realise that the scale needed to be a uniform one from the origin and went straight to the first given value of V. The plotting of the points was very good. However, some candidates' plots were too large and they produced blobs. They should be no larger than half of a small square on the graph. There were many good thin lines plotted. Lines of best fit should have an even distribution of points on either side and should not automatically be extended to the origin (0, 0).

(c) Most candidates correctly read their value of E from the graph.

(d) (i) Most candidates used the triangle method on the graph to calculate their gradient. However, it is better for large triangles to be used as they will give a more accurate value for the gradient.

(ii) The calculation was done reasonably well. Some candidates got a negative value and did not go back and check their previous results for any error.

(e) Several candidates suggested taking more values. Some did not say more values of voltage should be chosen. Only the strongest candidates suggested expanding the scale of the x-axis.

Question 3

(a) Most candidates correctly constructed and labelled the normal.

(b) Many candidates gained full credit for this question, but several did not place the pins far enough apart. A minimum separation of 5 cm is required.

(c) Most candidates measured the lengths a and b, and calculated n_1, correctly.

(d) (i) Most candidates measured the lengths c and d, and n_2 correctly. Many candidates realised that there was no unit for any value of n.

(ii) Only stronger candidates answered this correctly. Others did not realise that larger lengths lessen the effects of any error occurring.

(e) (i) Most candidates correctly measured the angle α.

(ii) Candidates gave many and varied incorrect answers with few stating that their results were within experimental error (or equivalent wording)

(f) Not many candidates realised that this question was not about poor experimental practice but about correct and precise experimental technique.

Question 4

Careful reading of the question, and the use of the bullet points as guidance about what was expected in the plan, enabled candidates to better address what was required to gain full credit.

Many candidates chose to have mass/weight as their independent variable with some using unsuitable values (e.g. 10 kg). Several candidates stated that a ruler was needed to take the necessary measurements. There was often a lack of detail about how these measurements would be taken. It is always a good idea for candidates to go back and read their method and see if they could then carry out the experiment. It was necessary for the method to include measurements for a minimum of five values of the independent variable, to repeat each value and to then take averages. Most candidates stated at least one correct control variable. Many candidates drew a table with the correct quantities. Some did not label the quantities with the correct units. Not many candidates explained how they would use their results. The use of a graph was the most common analysis that candidates used to gain credit.

PHYSICS

Paper 0625/61
Alternative to Practical

Key messages

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

General comments

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

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 showed evidence of undertaking regular practical work. Some candidates appeared to have learned sections from the mark schemes of past papers and written responses that were not appropriate to the questions set.

The practical nature of the examination should be kept in mind when explanations, justifications or suggested changes are required, for example in **Questions 1(e)**, **2(e)**, **3(e)** and **3(f)**.

Comments on specific questions

Question 1

(a) The majority of candidates successfully recorded 50 cm. Some appeared to have taken the measurement from the figure instead of from the information in the question.

(b) Most candidates calculated T and T^2 correctly. T^2 was expected to be given to three significant figures to be consistent with the other values in the table. Most candidates successfully gave the units, cm for distance and s for time, but many did not realise that the unit for T^2 is s^2.

(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 but some drew a dot-to-dot line whilst others drew a straight line that did not match the plots.

(d) Very few candidates realised that the line must pass through the origin to show a proportional relationship. Some candidates thought that a straight line was sufficient to show proportionality.

(e) Here candidates were expected to realise that timing errors at the beginning and end of the timing period are less significant when timing 10 oscillations. Some candidates appeared to refer to 10 separate timings of one oscillation giving an average result, not realising that a single time for 10 oscillations is the technique involved.

Question 2

(a) Most candidates recorded correct values for current and potential difference and included the units A and V. Most candidates calculated the resistance successfully, but the unit required was not always given.

(b) Here credit was awarded to those candidates who gave the resistance to 2 or 3 significant figures.

(c) Most candidates calculated the resistance correctly.

(d) The diagram required candidates to draw two resistors in parallel and have a complete circuit with correctly positioned ammeter and voltmeter with all the correct circuit symbols used.

(e) Candidates gained partial credit for suggesting the use of additional resistors. Some candidates realised that, in order to obtain a result with convincing validity, at least five sets of results would be required, adding a resistor each time.

(f) Successful candidates drew a clear variable resistor symbol. Others drew the thermistor symbol or a symbol that appeared to be a cross between a variable resistor and a thermistor.

Question 3

(a) Most candidates drew the normal correctly.

(b) Most candidates drew the lines **EF** and **GH** carefully and in the correct positions.

(c) Many candidates successfully drew the line **PQ** at 30° to the normal but some drew the line at 60° to the normal. A minority chose 45°. Candidates were expected to know that the pins P_1 and P_2 should be positioned at a distance of at least 5 cm apart.

(d) Most candidates measured the distances *a* and *b* correctly, but some did not include a correct unit (cm or mm). Calculations of *b*/*a* were usually correct, but a significant number of candidates did not realise that the ratio has no unit. Candidates who had followed the instructions with care obtained a value of *b*/*a* that was within the tolerance allowed.

(e) A significant number of candidates incorrectly suggested carrying out the experiment in a darkened room. Successful candidates made valid suggestions such as viewing the bases of the pins.

(f) Candidates were expected to suggest at least four additional angles of incidence with a range of at least 30° and all less than 90°.

Question 4

Candidates who followed the guidance in the question were able to write concisely and addressed all the necessary points. A significant number of 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.

Candidates needed to include a stop-watch (or other timing device) for initial credit to be awarded.

A concise explanation of the method was required. Candidates should concentrate on the readings that must be taken and the essential parts 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 note that the block must be removed from the hot water and then the temperatures taken over a period of time. Candidates then needed to make it clear that the procedure was repeated with blocks made of different metals. A vague reference to repeats was not sufficient as it was not clear whether candidates were referring to using different blocks or repeating the measurements with the same block.

Candidates were expected to identify at least one variable to keep constant. The dimensions of the blocks or the starting temperature of the hot water were correct suggestions.

Many candidates drew a suitable table. They were expected to include columns for the metal of the block, temperature and time with appropriate units.

Candidates were expected to explain how to reach a conclusion. A graph of temperature against time for each metal was a suitable suggestion or an explanation of how to relate the temperature drop for each metal to the rate of cooling. 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 do 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 reliability and control of variables.

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

General comments

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

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

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

The vast majority of candidates finished the paper and there were few questions left unanswered. Some candidates showed an exemplary understanding of practical skills but equally, there were those which demonstrated a lack of graph skills, poor understanding of significant figures and a lack of comprehension of good practice in carrying out experiments.

Comments on specific questions

Question 1

(a) Many candidates gave a sensible estimate of the volume of water that the beaker could hold when filled to the top. Overestimates were relatively rare. Most incorrect answers were underestimates, with many candidates quoting values of 250 cm^3 or less. Occasionally, an answer within the allowed range could not be credited because the candidate was too precise and quoted the answer to the nearest cm^3, or even less.

(b) Most candidates gave clear and concise accounts of how they would use the string and ruler to determine an accurate value of the circumference of the beaker. Of those candidates who wrapped the string around the beaker multiple times, a few forgot to make a suitable division. Another acceptable method used by a much smaller percentage of candidates was to place the string across the diameter of the beaker and divide their measured length by pi. Candidates who followed the suggestion, and produced a well-drawn diagram, gained credit from the diagram alone.

(c) Many candidates did not give an answer for this question. However, most calculations for the external volume of the beaker were correct, but many candidates then quoted their answer to too many significant figures.

(d) Some candidates seemed unfamiliar with the expression "to the nearest gram" and wrote down the mass of the beaker as 208.3 g. The subtraction to calculate the mass of sand in the beaker was almost always correct. The density calculation was usually correct, but occasionally an incorrect unit was provided. Common incorrect units seen were cm^3/g, Pa and M/V.

(e) The correct line of sight for an accurate reading of the volume of sand in the measuring cylinder was drawn by the majority of candidates. However, some candidates had drawn nothing in the measuring cylinder or the perpendicular viewing was not indicated.

Question 2

(a) Almost all candidates followed the instructions for the construction carefully and obtained full credit. A common error was to use a spacing of 5 mm instead of 5 cm between the lines **CD** and **EF**.

(b) The angle of incidence was usually accurately drawn. The most common error was to draw this angle to the mirror, and not the normal. A minority of candidates did not take enough care and, although the angle was drawn from the normal, it was outside the tolerance of 1° allowed.

(c) Most candidates suggested a suitable pin separation for ray-trace experiments and gave a value of between 5 cm and 10 cm. Occasionally a correct number, with the absence of a unit, resulted in no credit being awarded.

(d) The measurements of the lengths *b* and *a* were usually accurate. Most candidates included an appropriate unit. The ratio of *a*/*b* was almost always calculated correctly. There were occasional errors in rounding of the ratio and/or in quoting the ratio to 1 significant figure.

(e) The calculation was usually correct. There were sometimes errors as, although the ratio *a*/*b* is dimensionless, candidates included the unit mm or cm.

(f) Candidates were asked to compare the two values they had obtained for the ratio *a*/*b* and state whether these values could be considered to be equal. Most candidates were able to state whether or not their results supported the statement given. However, not all candidates were able to go on and give a convincing justification for their statements.

The idea of experimental tolerances, and whether two measured quantities are close enough to be considered equal was not well understood by the majority of candidates. Generally, if the values differ by 5% 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*". Between the values of 5% and 10%, either answer is acceptable provided that it is qualified by a phrase, such as "*yes, they are close enough to be considered to be equal*" or "*no, they are too far apart to be considered to be equal*".

(g) Only stronger candidates were able to suggest a practical reason as to why the results of this experiment may not be accurate. These candidates talked about the difficulty in lining up the pins, the pin thickness and the thickness of the mirror as being contributory factors. Most candidates gave examples of poor experimental technique, such as parallax error and not reading the ruler correctly, despite the wording of the question.

Question 3

(a) The reading and recording of the readings on the scales of the ammeter and voltmeter were not problematic for most candidates. When the readings were incorrectly quoted, common errors were 0.5, 0.3 and 0.8 V for the voltmeter and 0.26, 0.3, and 3.2 A for the ammeter.

The resistance of resistor R was almost always calculated correctly. Occasionally one or more of the required units for current, potential difference or resistance was missing.

(b) There was some good graph plotting this year. Candidates nearly always chose sensible horizontal and vertical scales. However, the instruction to start both axes at the origin was not followed by some candidates. 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 them 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 was forced through the origin.

The most common sources of error were:
- missing labels and/or units on the axes
- a choice of scales which meant that the plotted points did not occupy at least half of the grid
- plots that were too large which made it difficult to judge the accuracy of the plotted point
- dot-to-dot lines, instead of a single best-fit line.

(c) Most candidates obtained a correct value for the length of the resistance wire needed. Many of these candidates did not observe the instruction given to show their method clearly on the graph and, as a consequence, this could not be awarded credit for working.

(d) Many candidates gave a sensible estimate for the resistance of 100 cm of the resistance wire. The methods used varied greatly, but where working was shown few candidates used the simple method of proportionality. In many cases, no working was shown.

Question 4

Many candidates produced very good diagrams of the experimental set-up they would use. A suitable means of support for the loaded spring was expected, but despite a boss, clamp and stand being given to candidates in the list of apparatus available, many diagrams showed a spring hanging in the air, with no visible means of support.

Occasionally candidates mounted the spring horizontally.

Candidates were asked to give a list of metals suitable to be made into springs and at least three different metals were required to gain credit. The three most common answers given were copper, steel and aluminium. A sizeable minority of candidates incorrectly included plastic in their list of metals.

Most candidates obtained at least partial credit for describing how they would carry out the investigation. The most common error here was to neglect to state that the initial length of the spring needed to be measured/recorded before the loads were added, in order that the extension produced by the load could be calculated. Some candidates used a range of loads on each different spring, whereas others used a single, constant load. Both methods were equally suitable, but candidates who used a range of loads found it more difficult to explain how they would reach a conclusion upon analysis of their results. Some candidates who explained the procedure correctly when using the spring made from the first metal, did not continue and say that the experiment needed to be repeated for springs made from the other metals.

Most candidates stated a suitable variable they would need to keep constant whilst investigating the effect of material upon the extension of a spring. When the length of the spring was chosen as the variable to keep constant, candidates needed to state that it is the original length, and many did not do this.

The table was usually drawn correctly. Common errors were not including units in the headings, incorrect units, e.g. weight in g and not N, or not including a column for the material of the spring/metal.

Stronger candidates obtained credit for the conclusion by using a fixed load/mass in their methods and comparing the extensions of each spring or by drawing a bar chart. If a range of loads were used, only the strongest candidates suggested plotting an extension–load graph for each metal and comparing, or comparing the extensions for the same load in each range.

PHYSICS

Paper 0625/63
Alternative to Practical

Key messages

Candidates need to have a thorough grounding in practical work during the course. This should include discussion on the precautions that need to be taken to improve reliability. Candidates should have had significant experience in carrying out experiments themselves. Candidates should be made aware that the paper tests an understanding of experimental work and that explanations will need to be based on data with practical rather than theoretical considerations being taken.

Direct measurements should always be taken to the necessary accuracy, with calculations stated to the required number of significant figures, with the correct units and clear working shown where applicable. These techniques will be tested in the paper. The use of fractions is not allowed.

Questions should be read carefully so that a full understanding of what is required from the question is understood and that appropriate answers are given.

General comments

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

- graph plotting and interpretation
- manipulating data to obtain results
- drawing conclusions
- tabulating readings
- control of variables
- dealing with possible sources of error
- understanding the concepts of results being equal within the limits of experimental accuracy
- choosing the most suitable apparatus.

All parts of all tests were attempted and were successfully completed within the allotted time. Most candidates followed the instructions correctly and performed calculations to the required level of accuracy. It is expected that linear measurements are given to the nearest millimetre and calculated answers are stated to two or three significant figures as appropriate, with units included. Some candidates were unable to draw conclusions from provided evidence.

Comments on specific questions

Question 1

(a) Many candidates drew a diagram of either an eye perpendicular to the spring or a ruler parallel to the spring. Others successfully described the same precautions without a diagram.

(b) (i) Nearly all candidates successfully measured the stretched length of the spring to the nearest millimetre.

(ii) Most candidates calculated the correct extension from their results from **(a)** and **(b)(i)**.

(c) The majority of candidates measured the new stretched length and extension correctly. Some candidates did not show their working and/or omitted the unit.

(d) Many candidates measured the correct stretched length and extension. Most candidates correctly used the equation to calculate the density value with most giving their answers to two or three significant figures.

(e) Only stronger candidates answered this correctly with others either looking for a complicated answer or giving answers that had no relevance to the question.

(f) Most candidates recognised that this graph would be a straight line with only a few realising that to be directly proportional it would have to pass through the origin. Several candidates correctly identified that the graph would have a line with a constant positive gradient.

Question 2

(a) Many candidates correctly connected the voltmeter between P and Q.

(b) Most candidates correctly read the scale to be 0.64. Some candidates read the scale as 0.62. It is important for candidates to look carefully at the scale when shown.

(c) Most candidates labelled the axes correctly with the appropriate quantity and unit. Many candidates used the correct scales but some did not realise that the scale needed to be a uniform one from the origin and went straight to the first given value of *V*. The plotting of the points was very good. However, some candidates' plots were too large and they produced blobs. They should be no larger than half of a small square on the graph. There were many good thin lines plotted. Lines of best fit should have an even distribution of points on either side and should not automatically be extended their line to the origin (0, 0).

(d) Most candidates correctly read their value of *E* from the graph.

(e) (i) Most candidates used the triangle method on the graph to calculate their gradient. However, it is better for large triangles to be used as they will give a more accurate value for the gradient.

(ii) The calculation was done reasonably well. Some candidates got a negative value and did not go back and check their previous results for any error.

(f) Several candidates suggested taking more values. Some did not say more values of voltage should be chosen. Only the strongest candidates suggested expanding the scale of the x-axis.

Question 3

(a) (i) Most candidates correctly constructed and labelled the normal.

(ii) The majority of candidates correctly measured this angle.

(b) Many candidates stated that a distance of at least 5 cm was needed and as such the pins were not a suitable distance apart.

(c) There were many good and accurate lines drawn.

(d) (i) Most candidates measured the lengths *a* and *b* correctly.

(ii) Many candidates correctly calculated *n* and realised that there was no unit for *n*.

(e) (i) Most candidates correctly measured the angle α.

(ii) Candidates gave many and varied incorrect answers with few stating that their results were within experimental error (or equivalent wording).

(f) Not many candidates stated a suitable precaution, such as using thin pins or lines.

(g) Few candidates realised that this question was not about poor experimental practice but about correct and precise experimental technique.

Question 4

Careful reading of the question, and the use of the bullet points as guidance about what was expected in the plan, enabled candidates to better address what was required to gain full credit.

Many candidates chose to have mass/weight as their independent variable with some using unsuitable values (e.g. 10 kg). Many candidates stated that a ruler was needed to take the necessary measurements. There was often a lack of detail about how these measurements would be taken. It is always a good idea for candidates to go back and read their method and see if they could then carry out the experiment. It was necessary for the method to include measurements for a minimum of five values of the independent variable, to repeat each value and to then take averages. Most candidates stated at least one correct control variable. Many candidates drew a table with the correct quantities. Some did not label the quantities with the correct units. Not many candidates explained how they would use their results. The use of a graph was the most common analysis that candidates used to gain credit.