PHYSICS

Paper 0625/11
Multiple Choice (Core)

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

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

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

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

General comments

Candidates demonstrated very good knowledge of what happens to the particles in a gas at constant volume when the temperature is increased, and of reducing the health risks when handling radioactive materials. However, there were some misconceptions about the resistance of resistors in parallel.

It was evident that longitudinal waves and the direction of a magnetic field around a bar magnet were not well understood.

Comments on specific questions

Question 1

The vast majority of candidates were able to choose the instrument used to measure a volume of water.

Question 4

Most stronger candidates were able to identify the information needed to predict whether a solid floats in a liquid. Although most weaker candidates recognised that the density of the liquid would need to be known, the majority of these candidates thought that it was also necessary to know the mass of the solid instead of the density of the solid, and therefore chose option **A**.

Question 18

The majority of candidates found this question challenging with only the strongest candidates correctly identifying the type and the name of the seismic wave described. Most weaker candidates recognised that a longitudinal wave was being described but incorrectly thought it was an S-wave.

Question 19

Most candidates found this question very challenging with only a small number of candidates correctly determining the speed at which the image moved away from the person. Most candidates incorrectly chose option **A** as they did not recognise that both the distance from the person to the mirror and the distance from the mirror to the image increase.

Question 24

This question assessed candidates' knowledge of the magnetic field around a bar magnet and was not well answered. Candidates' responses were fairly evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 27

The majority of candidates found this question very challenging as they did not make the link that potential difference is the energy transferred by one coulomb of charge as it passes through the component. Most candidates multiplied the numbers in the question together and therefore chose option **D**.

PHYSICS

Paper 0625/12
Multiple Choice (Core)

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

General comments

Candidates demonstrated very good knowledge of properties of a solid and nuclide notation. However, there were some misconceptions about what happens to the mass and volume of steam produced when water boils, and what happens to the speed of air particles when the volume of the air increases at constant temperature.

It was evident that some symbols, units and half-life calculations were not well understood.

Comments on specific questions

Question 5

Most stronger candidates were able to identify which quantity was represented by the symbol ρ. However, weaker candidates confused the symbol with p for pressure and therefore chose option **C**.

Question 7

Although many stronger candidates recalled the unit of the moment of the force correctly, weaker candidates' responses were mainly evenly distributed across the three incorrect options, indicating that many had guessed the answer. Candidates could benefit from short activities in lessons where they identify the units of different quantities.

Question 11

The majority of candidates found this question challenging. There was a common misconception that when water boils, the mass of the steam produced is less that the mass of the water lost through boiling.

Question 12

Nearly all candidates demonstrated very good knowledge of properties of a solid.

Question 13

This question required candidates to describe how the average speed of air particles and the average distance between air particles changed when the volume of the air decreased. Although the majority of candidates knew that the average distance between air particles decreased, there was a common misconception that the average speed of the particles increased, even though the temperature of the air remained constant.

Question 16

The majority of candidates, especially weaker candidates, had the misconception that evaporation takes place when part of a liquid rises due to its density decreasing.

Question 19

Weaker candidates demonstrated a poor understanding of seismic waves. The most common incorrect answer was that S waves are longitudinal, and P waves are transverse.

Question 20

Although many candidates were able to interpret the information correctly in order to determine the angle of incidence, a similar number of candidates did not read the information carefully enough and subtracted the value given in the question from 90°. Drawing a simple sketch may help candidates in this type of question.

Question 23

Although most candidates demonstrated knowledge of the order of the colours in the visible spectrum, it was evident that many were confused about whether the colours are in order of increasing or decreasing wavelength. Therefore, the most common answer was option **C**.

Question 32

This question assessed candidates' knowledge of the direction of the magnetic field around a solenoid and was not well answered. Candidates' responses were fairly evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 35

Candidates' knowledge of background radiation was assessed in this question. Most candidates were able to identify alpha particles from radon gas as being a source of background radiation but there was a common misconception that infrared radiation from the Sun was also an example of background radiation.

Question 37

The majority of candidates found this question very challenging and demonstrated poor understanding of half-life calculations. The most common error was to simply divide 87 by 8. Only a small number of candidates recognised that 3 half-lives had occurred during 87 hours.

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

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

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

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

General comments

Candidates demonstrated very good knowledge of the equation to determine the orbital speed of a satellite, and an advantage of connecting lamps in parallel. However, there were some misconceptions about beta emission and infrared emission.

It was evident that unit prefixes, unit conversions and the transmission of electrical power using transformers were not always well understood.

Comments on specific questions

Question 4

Most stronger candidates demonstrated a good understanding of density and related this to why a liquid will float on top of another liquid. Many weaker candidates had the misconception that a liquid will float on top of another liquid if it has a smaller mass.

Question 9

This question assessed candidates' knowledge of how pressure in a liquid varies with depth. The majority of stronger candidates answered this question correctly, but weaker candidates' responses were fairly evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 13

Stronger candidates performed very well on this question which required them to equate the energy transferred from the brass block to the energy transferred to the water. Weaker candidates struggled to answer this correctly. The most common error was to use the final temperature instead of the temperature change when calculating the energy transferred to the water.

Question 16

Most stronger candidates recalled that dull black surfaces emit infrared radiation at a greater rate than shiny silver surfaces. However, many weaker candidates thought shiny silver surfaces emitted infrared radiation at a greater rate.

Question 22

This question required candidates to compare the wavelength and the frequency of ultraviolet radiation and infrared radiation. Weaker candidates found this challenging and the majority of these candidates' answers had the comparisons the wrong way round.

Question 25

Candidates appeared to recall the correct equation to use in this question but struggled with unit prefixes and converting from seconds to hours. The most common incorrect answer was option **B**, suggesting that candidates had a power of 10 error when converting mA to A, and then made errors when converting units of time. Candidates could benefit from short activities where they practise using unit prefixes and converting between units.

Question 30

The majority of candidates were able to recall that the output e.m.f. of an electrical generator would increase as the number of turns on the coil increases.

Question 33

Some candidates appeared not to have read the information provided about the reaction carefully enough and did not take into account that the nucleus of plutonium absorbed a neutron, resulting in the nucleon number of plutonium increasing to 240. Candidates may have benefitted from writing the decay equation using nuclide notation so that they had a clearer idea of what was happening in terms of the nucleon numbers and proton numbers.

Question 34

The majority of candidates found this question very challenging and showed a poor understanding of the nature of alpha particles and beta particles. Weaker candidates' responses were fairly evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 35

This question assessed candidates' knowledge of the change in a nucleus during beta emission. Although the majority of stronger candidates answered this correctly, many weaker candidates had the misconception that during beta emission, an electron is emitted from an outer electron shell of an atom.

Question 36

Although the vast majority of candidates knew that a radioisotope must emit gamma to make it suitable to kill bacteria, many of these candidates did not realise that a half-life of several hours would be better than a half-life of less than one minute.

Question 38

Candidates demonstrated excellent recall of the equation to determine the orbital speed of a satellite in orbit around the Earth.

PHYSICS

Paper 0625/22
Multiple Choice (Extended)

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

General comments

Candidates demonstrated very good knowledge of the equation relating mass and weight, and the effect of increasing air pressure on the average speed of particles and the temperature of the air. However, there were some misconceptions about speed-time graphs and what happens to the temperature of a substance while it is melting.

It was evident that energy stores and double-insulated appliances were not always well understood.

Comments on specific questions

Question 2

The majority of candidates demonstrated a good understanding of speed-time graphs, with nearly all stronger candidates answering correctly. Some weaker candidates had the misconception that the deceleration of an object is calculated from the area under the graph.

Question 6

Stronger candidates demonstrated good application of the law of conservation of momentum. Weaker candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 7

This question assessed candidates' knowledge of energy stores. Many candidates found interpreting the information challenging, with the most common incorrect answer being option **B**.

Question 12

Stronger candidates showed a very good understanding of the relative order of magnitudes of the expansions of solids, liquids and gases as their temperatures rise. Weaker candidates either misinterpreted the diagrams or had the misconception that solids expand the most.

Question 14

The vast majority of stronger candidates correctly recalled that when a substance melts, there is no change in temperature. However, most weaker candidates had the misconception that the temperature of a substance increases when it melts.

Question 15

This question assessed candidates' knowledge of thermal energy transfer. Weaker candidates' responses were fairly evenly distributed across the four possible options, indicating that many had guessed the answer. The most common incorrect answer was option **D**.

Question 23

In this question, candidates were required to compare a compression in a sound wave in air with a rarefaction. Most stronger candidates correctly recalled the difference in the density of the air, but weaker candidates thought it was the wavelength of the sound wave that was different.

Question 25

Many candidates found this question challenging. The majority of candidates were able to determine the e.m.f. of the battery and therefore chose either option **A** or option **B**. However, most candidates incorrectly chose option **A** as they did not recognise that two of the three lamps were in parallel.

Question 26

Weaker candidates struggled with this question relating the resistance of a metal wire to its length and diameter. Responses were fairly evenly distributed across the four possible options, indicating that many had guessed the answer. The most common incorrect answer was option **D** because candidates multiplied the diameter by the same factor as the length rather by the square root of the length factor. Candidates did not take into account that for the same resistance, if the length is multiplied by 4, the area must be multiplied by 4 so the diameter would have to be multiplied by 2.

Question 29

Candidates did not demonstrate a good understanding of double-insulated appliances, with evidence of guesswork, especially from weaker candidates.

Question 33

This question assessed candidates' knowledge of the scattering of alpha particles by a sheet of thin gold. Option **A** and option **B** were the most common answers, with the majority of weaker candidates thinking that the alpha particle would be deflected towards the top of the page instead of being deflected back along its initial path.

Question 40

The majority of candidates demonstrated good knowledge of what could happen after a supernova explosion. Weaker candidates' answers were more evenly distributed across the four possible options, with a red supergiant star being the most common incorrect answer.

PHYSICS

Paper 0625/23
Multiple Choice (Extended)

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

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

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

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

General comments

Candidates demonstrated very good knowledge of measuring instruments and the effect of changing the amplitude and frequency of a sound wave. However, there were some misconceptions about the speed of different regions of the electromagnetic spectrum.

It was evident that average speed calculations and manipulating count rates to take background radiation into account were not always well understood.

Comments on specific questions

Question 2

The majority of candidates found this question about average speed challenging as they calculated the initial speed of the car instead of the average speed.

Question 4

Nearly all candidates were able to identify the measuring instrument used to compare masses.

Question 10

Although most stronger candidates answered this question correctly, a significant number of weaker candidates had the misconception that the Sun is the main source of energy for geothermal energy.

Question 12

Most candidates found this question very challenging and had difficulty in completing all of the steps to reach the final answer. There was evidence that when calculating the new pressure of the gas, stronger candidates took into account that the volume of the gas was decreased by 15 cm^3 and therefore chose either option **B** or option **D**. However, candidates who chose option **D** did not take the final step of determining the change in the pressure by subtracting the original pressure of the gas. Weaker candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 18

This question assessed candidates' knowledge of how the wavelength and gap size affects diffraction through a gap. The majority of stronger candidates answered this correctly, but most weaker candidates chose option **D**.

Question 20

Most stronger candidates recalled the correct equations to use. Most weaker candidates simply divided the speed of light in a vacuum by the speed of light in glass and multiplied by 40, and therefore chose option **C**.

Question 22

Stronger candidates demonstrated an excellent understanding of regions of the electromagnetic spectrum. Weaker candidates' responses were fairly evenly distributed across the four possible options, indicating that many had guessed the answer. The most common incorrect answer from weaker candidates was option **C**, which suggested that some candidates had the misconception that different regions travel at different speeds.

Question 23

The majority of candidates found this question straightforward and demonstrated a very good understanding of sound waves.

Question 28

Nearly all stronger candidates applied the equation $E = VIt$ in this question and were able to use unit prefixes and convert units correctly. Weaker candidates found it more challenging and appeared to simply multiply 3 by 20, ignoring both the prefix and the time, and therefore chose option **C**.

Question 31

The majority of candidates found this question very challenging and demonstrated poor understanding of which circuit allowed the p.d across the lamp to be varied form 0 V to 6.0 V. Answers were fairly evenly distributed across the four possible options, suggesting that most candidates had guessed the answer.

Question 33

In this question, candidates firstly had to determine the value for the mean number of counts in 10 minutes of the background radiation. Then they had to use this value to determine the mean count rate for background radiation (in counts per minute) and finally subtract this from the count rate measured when the detector was near the radioactive source. Only the strongest candidates could do this successfully. The most common error was to not take into account that the mean value calculated from the table was the number of counts in 10 minutes and was not the count rate.

Question 40

The majority of stronger candidates demonstrated good knowledge of supernovas. Weaker candidates' responses were more evenly spread over all four possible options.

PHYSICS

Paper 0625/31
Theory (Core)

Key messages

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

Some of the candidates' handwriting made it difficult to distinguish what they were writing. There were some 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. They were able to apply their knowledge and physics understanding to the questions set and produced correct responses.

Some candidates struggled to express themselves adequately when answering the extended writing questions. One example of this was the use of the pronouns 'it' and 'they' without making it clear what 'it' and 'they' referred to. This ambiguity made it difficult for credit to be awarded. Similarly, candidates frequently stated a property had changed but did not state how it had changed or what the property was. For example, in **Question 1(b)(i)** many candidates stated that the motion was constant, but they did not say that the speed was constant and so did not gain credit here.

Almost all candidates attempted all of the items and there was no evidence of candidates being short of time.

Comments on specific questions

Question 1

(a) Most candidates answered correctly determining the speed during the first 10 s on the speed-time graph. The correct answer was 10 (m / s). The most common error was to substitute incorrect values from the graph or to try and find the area below the graph line.

(b) (i) Many candidates gained credit for constant or steady speed. The most common errors were to mistake the graph for a speed-time graph and so state that the cyclist was accelerating.

(ii) Many candidates gained credit for stationary or at rest. The most common errors were to mistake the graph for a speed-time graph and so state that the cyclist was moving at steady speed. Weaker candidates simply said the motion was constant.

Question 2

(a) (i) Most candidates correctly determined the volume reading on the measuring cylinder.

(ii) Many candidates correctly divided the volume of water by the number of drops to give a correct answer of 0.20 (cm^3). The most common error was to divide the number of drops by the volume of water i.e. 120 ÷ 24 to give an answer of 5.

(b) Most candidates made a correct comparison of densities and gave a correct reason for their comparison. However, some candidates thought the density was higher because the plastic was floating on the water. There were a few candidates that did not give any answer.

Question 3

(a) The majority of candidates calculated the correct answer of 2.5 (N). The most common error was to divide by g rather than multiply the mass by g.

(b) (i) Some candidates found this item challenging but the majority correctly determined the length as 48.5 (cm). Candidates should be reminded to draw construction lines on the graph to show their working. Many did this and could be awarded partial credit despite an incorrect reading from the y-axis.

(ii) Only stronger candidates correctly extended the graph at the same gradient until it crossed the y-axis to obtain an answer of 33.5 cm. The most common errors were to either extend the line horizontally and state that the length of the spring was 29 cm or to join the graph line to the origin and state that the length of the spring was zero.

Question 4

(a) (i) The majority of candidates were able to correctly recall the equation for work done and evaluated the work done on the load as 240 J. The most common error was to divide the force by the distance instead of multiplying them.

(ii) Many candidates gained full credit for stating that the chemical energy is transferred to any two from: a kinetic energy (store), a gravitational potential energy (store) or a thermal/internal energy (store). A common error was to only state one energy store.

(b) Most candidates were able to correctly recall the equation for power and evaluated the power output as120 W. The most common error was to multiply the work by the distance to give an answer of 108 000 W.

Question 5

(a) The simple kinetic molecular model of matter was well understood by most candidates.

(b) Many candidates gained partial credit here but very few scored full credit. How particles of the gas exert a pressure on the inside surface of the metal cylinder was not well understood.

(c) This calculation was done very well and most candidates gained full credit by calculating the pressure as 1.4 (N / cm^2). A common error was to use an incorrect rearrangement of the equation $P = F \div A$.

Question 6

(a) (i) Most candidates correctly identified region 1 as ultraviolet and region 2 as X-rays. A common error was to interchange the names of the 2 regions. Weaker candidates repeated some of the regions already on the chart.

(ii) Almost all candidates gained credit here. The most common answer was sterilising medical instruments, but many other correct uses were seen. A common error was to suggest that gamma rays were used to take X-rays.

(iii) Most candidates gave a suitable harmful effect of gamma rays. Where credit could not be awarded it was usually due to a lack of precision in the answer, e.g. “it can cause skin disease” or “it can cause skin damage”.

(b) Most candidates were able to correctly recall the equation $v = f\lambda$ and then rearranged and evaluated the wavelength as 140 m. The most common error was to use an incorrect rearrangement of the equation. For example, some candidates divided the frequency by the speed or multiplied the speed by the frequency. Some candidates did not divide the powers of 10 correctly.

Question 7

(a) Most candidates scored only partial credit, with the most common error being thinking that unmagnetised steel would not be attracted to a magnet.

(b) Very few candidates could recall that a magnetic field is the region/area in which a magnetic pole experiences a force or a region/area in which a magnetic material experiences a force.

(c) (i) Although many candidates answered this correctly, a number of candidates could not name an electrical conductor and an electrical insulator. Many answers were too vague for credit to be awarded. For example, a number of candidates stated that a wire is a conductor without realising that wires are usually made up from a conducting copper core and an outer insulating layer of plastic.

(ii) Most candidates scored credit here for stating that electrons or charges were able to move freely through conducting materials. However, many only scored partial credit as they stated that metals contained free electrons but did not state that the electrons could move throughout the metal.

Question 8

(a) The majority of candidates were able to correctly recall the equation $V = I \times R$ and then rearranged and evaluated the resistance as 3000 (Ω). The most common error was to use an incorrect rearrangement of the equation. For example, some candidates divided the current by the voltage (p.d.) or multiplied the current by the voltage.

(b) Most candidates were able to correctly recall the transformer equation and then rearranged and evaluated the output voltage as 15 V. The most common error was to use an incorrect rearrangement of the equation. Many candidates gave the correct equation and then showed a correct substitution of values into the equation. Candidates should be reminded to show working so that partial credit can be given for any correct working.

(c) Many candidates were able to correctly recall the equation $P = I \times V$ and then convert the current from mA to A and evaluate the power as 0.14 W. However, most candidates used an incorrect conversion of the current from mA to A.

(d) Candidates found question challenging, possibly due to the need to multiply 3 numbers together. Almost all candidates who finished with the wrong answer did so by multiplying two of the numbers but not the third. Most candidates did not realise that the cost of using the television was calculated using cost = energy in kW h × number of hours × cost of one unit of energy.

Question 9

(a) The majority of candidates identified the circuit as a series circuit. The most common error was to state that it was a parallel circuit.

(b) The majority of candidates gave an answer of 16 Ω. Some candidates calculated the resistance for a parallel combination or simply multiplied the two values to give an answer of 64 Ω.

(c) The majority of candidates gained at least partial credit here with clear symbols correctly connected. The most common error was to draw a battery symbol instead of a cell. Other candidates did not recall the symbol for a switch.

Question 10

(a) Many candidates gave the correct nuclide notation for radium-223. The most common error was to transpose the proton and nucleon numbers. Other candidates gave the number of neutrons instead of the number of nucleons.

(b) Almost all candidates were able to determine the number of neutrons by subtracting the proton number from the nucleon number to give 135. Common errors were adding instead of subtracting or simply stating the nucleon number.

(c) A majority of candidates were able to demonstrate that from 32 mg to 4 mg needed three halvings. However, many were then unable to state that this would take three half-lives and so gave a total time of (3 × 11) =) 33 days.

Question 11

(a) Many candidates found this item challenging with only a few stating the reason as Earth having a greater mass. The most common error was to state that the reason why the gravitational field strength at the surface of the Earth is greater than the gravitational field strength at the surface of Mars was because the Earth was closer to the Sun. This was a common misconception.

(b) Most candidates were able to state the names of the four gaseous planets further from the Sun than Mars and listed the planets in order of increasing distance from the Sun. The most common error was to list the four planets closest to the Sun. Other candidates included Pluto as a planet.

(c) Most candidates scored full credit for calculating the time as 433 or 430 seconds. Common errors included using an incorrect rearrangement of speed = distance ÷ time or an incorrect division of the powers of ten.

PHYSICS

Paper 0625/32
Theory (Core)

Key messages

Candidates should refer to, and follow, the instructions on the front page of the question paper, namely '*Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m / s²)'*.

Candidates could benefit from experience of practical or online experiments in which they practise using scientific key words, measurement techniques and drawing links between concepts and physical contexts.

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

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

In calculations, candidates should set out and explain their working clearly. Credit may be given for correct working even if the final numerical answer is incorrect. Candidates who wish to change their final answer should cross out the incorrect version and clearly write the correct value.

Candidates generally showed clear working when solving numerical questions by stating the formula first, then substituting in the given values and then working out the answer.

General comments

Some areas of the syllabus were better known than others. Equations were generally well known and many candidates understood how to apply equations to standard situations well. Weaker candidates would have benefitted from more practice at rearranging equations. In particular, energy stores, thin lenses, sound, electromagnetic induction and aspects of the Universe were not well understood.

For many candidates, the non-numerical questions were more challenging than the numerical questions. A number of candidates struggled to express themselves adequately when answering the extended writing questions. An example of this was the use of the pronouns 'it' and 'they' without making it clear what 'it' and 'they' referred to. Similarly, candidates frequently stated a property had changed but did not state how it had changed i.e. whether it had increased or decreased.

Comments on specific questions

Question 1

(a) (i) The majority of candidates gave an answer within the accepted tolerance. A few incorrect answers of 7.4 m / s were seen. This was the maximum speed of the cyclist.

(ii) Again, the majority of the candidates correctly identified that the speed was decelerating. Other answers were often too vague, e.g. 'it decreases' rather than 'the speed decreases'.

(iii) Many candidates recalled that the distance travelled was equal to the area under the speed–time graph. They usually applied this knowledge successfully. Others misread the scale on the speed axis. In these cases, credit for method could be awarded. Weaker candidates usually scored partial credit for knowing that *distance = speed × time*.

(b) The vast majority of the candidates gave the correct answer with most showing both the correct equation and full working.

Question 2

(a) A large number of candidates gained full credit. A clear direction needed to be indicated, i.e. backwards or forwards or to the left or to the right. The answer 'east' required the points of the compass to be shown as well and 'in front' was too vague.

(b) The vast majority of candidates gained full credit again showing both the correct equation and full working. Only a few errors were seen: namely, using the incorrect equation *pressure* = *force* × *area* or squaring the given area of 6.2 cm^2 before substituting into a correct equation.

(c) Most candidates correctly recalled the equation in the form $W = mg$. Rearranging the equation to determine the mass proved challenging for weaker candidates. Some of these candidates began their calculation with an incorrect equation, e.g. $m = Wg$.

Question 3

(a) Stronger candidates displayed knowledge of the principle of conservation of energy, particularly that energy cannot be created or destroyed. Some responses, such as quoting the equation *energy (= work done) = force* × *distance* or stating one or more energy stores, did not answer the question. There were a significant number of candidates who did not give a response to this question.

(b) Candidates would have benefitted from more practice at energy flow diagrams. A number of correct answers were seen but many candidates gave kinetic energy and potential energy as the energy transfers.

(c) (i) The vast majority of candidates answered this 'show that' question well, starting with the equation for work done and detailing the stages of the calculation.

(ii) A large number of candidates gained at least partial credit with most showing both the correct equation and full working. For full credit, a greater understanding of units was needed. The most common error was 'joule'.

Question 4

(a) The most common answer related to the ability of each wave to travel in a vacuum or not. Light being a transverse wave and sound being a longitudinal wave were less frequent answers and confusion between the two types of waves was also evident.

(b) The majority of candidates lacked detailed knowledge of this experiment. Partial credit was awarded for generic statements, e.g. 'time measured using a stopwatch' or *speed* = *distance* ÷ *time*. A number of candidates did not answer this question.

(c) Many candidates scored full credit for an answer of 1.3 m with most showing both the correct equation and full working. The most common error was using an incorrect rearrangement of the wave equation, usually $\lambda = fv$ or $w = fv$.

Question 5

(a) (i) The majority of candidates gave the correct answer. Some answers seen were too vague, e.g. unspecified 'denser' rather than 'water is denser (than ice)'.

(ii) This question was answered well by many candidates, with both the density equation and full working seen. There were a significant number of incorrect answers obtained by multiplying the density by gravitational field strength.

(b) (i) The vast majority of candidates were aware that melting was the required process.

(ii) Generally, candidates displayed a good knowledge of the changes in the arrangement and motion of the particles. Some answers were too vague to gain credit, e.g. for the arrangement: an unspecified ‘regular’ rather than ‘regular when solid’ or an unspecified ‘random’ rather than ‘random when liquid’.

(c) Most candidates were aware that evaporation was the required process. A common error was boiling.

Question 6

A significant number of candidates did not answer parts of this question.

(a) Recall of principal axis was rarely seen. The most common answer was the normal.

(b) Although many correct answers were seen, vague answers such as ‘focus’ were insufficient. A common incorrect answer was ‘focal length’. The question asked for the name of the points. Candidates would have benefitted from more careful reading of the question.

(c) Candidates that answered this part generally recognised that the ray would continue through F to the tip of the image.

(d) Those candidates who drew a ray from the tip of the object were usually correct, especially if the ray went through the centre of the lens undeviated.

(e) A number of candidates answered this question well. Common errors for another characteristic were virtual and upside down, which was given in the question.

Question 7

(a) A common error was *1.5 V*, being the potential difference across one cell rather than across the four cells in series.

(b) (i) Many candidates scored full credit for an answer of 9.1 Ω. Almost all answers showed both the correct equation and full working. Candidates should be reminded that numerical answers should be expressed to two significant figures unless otherwise stated. A noticeable number of answers were only given to one significant figure. Another common error was using an incorrect rearrangement of the equation $V = IR$.

(ii) Few candidates were able to recall the equation $E = IVt$. Many candidates either used the incorrect equation of $E = IVR$ or calculated the power using $P = IV$. A number of candidates did not give a response to this question.

(c) The required knowledge was that the combined resistance of two resistors in parallel is less than that of either resistor by itself. Therefore, the second lamp needed to be dawn in parallel with the original lamp.

Question 8

(a) (i) Candidates needed to apply the knowledge that a changing magnetic field linking a conductor can induce an e.m.f. in the conductor. A few answers referred to an induced e.m.f. or an induced current.

(ii) Many correct answers were seen but other answers were too vague to gain credit, e.g. use a ‘bigger’ magnet rather than a ‘stronger’ magnet or use ‘bigger’ coils rather than use a ‘coil with more turns’. Candidates had clearly been prepared for similar questions to this one but increasing the current or increasing the potential difference did not apply to the given situation.

(b) (i) There was some confusion between the properties of temporary magnets (made of soft iron) and the properties of permanent magnets (made of steel). A number of candidates did not give a response to this question.

(ii) Many correct answers of copper were seen. Common errors were (soft) iron and aluminium. There were a noticeable number of blank responses.

Question 9

(a) This item was answered well by many candidates but there was some minor confusion between alpha-particles (α-particles) and beta-particles (β-particles).

(b) (i) Many candidates gained full credit for knowledge of an isotope. A common error was to interchange protons with neutrons. Some candidates did not give a response to this question.

(ii) Many correct answers were seen with the associated working. A common error was to divide the maximum count rate of 240 by the maximum time of 40 giving an incorrect answer *of* 6 days. Candidates generally would have benefitted from more understanding of the concept of half-life.

Question 10

(a) (i) Many correct answers were seen. Common errors were particles or molecules.

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

(iii) Only a few candidates displayed knowledge of the accretion model. There were a large number of blank responses.

(b) A noticeable number of candidates gained full credit, usually for ‘red-shift’ as the evidence and ‘the Universe is expanding’ as the explanation. A number of candidates did not give any answer to this question.

PHYSICS

Paper 0625/33
Theory (Core)

Key messages

Candidates should refer to, and follow, the instructions on the front page of the question booklet, namely '*Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m / s²)'.*

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

In calculations, candidates should set out and explain their working clearly. Credit may be given for correct working even if the final answer is incorrect. Candidates who wish to change their final numerical answer should cross out the incorrect version and clearly write the correct value.

General comments

Some areas of the syllabus were better known than others. Equations were generally well known by all but the weakest candidates. Many candidates understood how to apply equations to standard situations well. Weaker candidates would have benefited from more practice at rearranging equations. In particular, states of matter and particle model, refraction and action of thin lenses, and the structure of a transformer were not well understood.

For many candidates, the non-numerical questions were more challenging than the numerical questions. A number of candidates struggled to express themselves adequately when answering the extended writing questions. An example of this was the use of the pronouns 'it' and 'they' without making it clear what 'it' and 'they' referred to. Similarly, candidates frequently stated a property had changed but did not state how it had changed i.e. whether it had increased or decreased.

Comments on specific questions

Question 1

(a) (i) The majority of candidates were able to read the correct speed value from the graph.

(ii) Many candidates correctly identified that the stone was accelerating. Other answers were often too vague, e.g. 'it increases' rather than 'the speed increases'.

(iii) Candidates needed to understand that the distance travelled is equal to the area under a speed–time graph. Many gained partial credit for knowing that *distance = speed × time*.

(b) Some candidates correctly recalled the equation in the form $W = m \times g$ but rearranging the equation to determine the mass was challenging for many candidates. Other candidates began their calculation with an incorrect equation, e.g. $m = W \times g$. A noticeable number of candidates did not give any response to this question.

Question 2

(a) A significant number of candidates gained full credit here and who showed full working. A common error was to use the incorrect equation *moment = force ÷ (perpendicular) distance.*

(b) The majority of candidates gained full credit here, again showing both the correct equation and full working.

(c) Again, most candidates gained full credit by showing full working and giving the correct unit. However, a noticeable number of candidates did not give any response to this question.

Question 3

(a) A significant number of excellent responses detailed the stages of determining the density of a liquid and included the correct equation. Other answers lacked detail, e.g. omitting to name the measuring instruments required to find the mass and volume of the seawater. Some candidates had not read the question carefully enough and described a distillation experiment.

(b) Candidates were generally able to determine whether objects float based on density data.

Question 4

(a) (i) Many correct answers were seen. A common error was to say that the substance was melting.

(ii) Candidates needed to understand that a horizontal part of the graph indicates a change of state; in this case from solid to liquid. A very common incorrect answer was ‘no effect’.

(iii) Many candidates did not read the question carefully enough as the majority of answers were 100 °C which is the boiling temperature of water rather than of the substance in this question.

(iv) Again, candidates would have benefitted from more careful reading of the question. The state of matter was required, i.e. ‘gas’ not the process, ‘evaporation’ or ‘boiling’, both of which were common incorrect answers. There were a number of candidates who did not give any answer to this question.

(b) (i) Only stronger candidates showed a full understanding of the evaporation process. Most candidates recognised that the liquid particles would change into vapour particles.

(ii) A significant number of candidates appeared to have misread the question. The question asked for ‘another effect’ i.e. in addition to ‘the puddle drying up’ which was given in the question. Therefore, the knowledge that the remaining liquid would cool was rarely seen.

Question 5

(a) Most candidates were familiar with the advantages and disadvantages of the energy resources.

(b) (i) Only stronger candidates knew that the required property was that light can travel through a vacuum. There were many incorrect answers and a number of candidates did not give any answer.

(ii) Some candidates gained full credit for an answer of 5.0×10^7 m with most showing both the correct equation and full working. The most common error was using an incorrect rearrangement of the wave equation, usually $\lambda = f \times v$ *or* $w = f \times v$. Again some candidates did not offer any answer here.

(c) There was often confusion regarding the order, in terms of frequency, of the regions of the electromagnetic spectrum. The most common incorrect answer was ultraviolet. Often, the uses given, were too vague, e.g. ‘radio waves’ used to ‘transmit sound’ instead of ‘radio and/or television transmissions’ or ‘pain relief ‘or’ wound healing’ for a use of infrared rather than just ‘medical’. This use of infrared is not specified in the syllabus, nevertheless it is a valid use, so gained full credit when given.

Question 6

There were a significant number of no responses for all parts of this question

(a) Recall of principal axis was not seen and the most common answer was the normal.

(b) Candidates need to take care when taking measurements. There were a number of answers which were outside the allowed tolerance.

(c) Those candidates who drew a ray from the tip of the object were usually correct, especially if the ray went through the centre of the lens undeviated.

(d) Again, candidates would have benefitted from more careful reading of the question. Answers that just indicated the point where rays, from the tip of the object, crossed could only be awarded partial credit. An upside-down arrow from this point to the principal axis was required for full credit.

Question 7

(a) (i) (ii) Most candidates answered these two questions very well.

(b) (i) The majority of candidates scored full credit for an answer of 24 Ω with almost all answers showing both the correct equation and full working. The most common error was using an incorrect rearrangement of the equation $V = I \times R$.

(ii) Candidates who were able to recall that *power* = *potential difference* × *current* usually gave full answers. Others often repeated their answer to **(i)** or gave no response.

Question 8

(a) Many candidates recognised that that the current would be smaller and/or that less power would be lost. Other answers were too vague, e.g. 'more cost effective' rather than giving detail such as, 'thinner cables could be used which are cheaper' or 'fewer power stations required' (because less power would be lost during transmission). A number of candidates did not give any response.

(b) Candidates needed to recognise that the thermal energy transfer required was from the transformer to the surroundings. The explanation needed to refer to the effectiveness of the emission of infrared radiation by a black surface rather than the absorption.

(c) Candidates generally lacked the knowledge of the details of a transformer. Answers often just recalling the transformer equation, but many candidates did not give an answer.

Question 9

(a) This question was answered well by many candidates. There was sometimes confusion between electrons and protons and their locations.

(b) The answers seen were generally correct, but a common error was interchanging alpha-particles (α-particles) with beta-particles (β-particles).

(c) Most candidates gained partial credit, usually for storing in a lead (-lined) container. Precautions such as 'wear protective clothing', were too vague and did not answer the question. Ideas relating to security, remote locations, radiation signs etc. were acceptable precautions for storing radioactive materials.

Question 10

(a) A high number of correct answers were seen.

(b) (i) A large number of candidates answered this question well with hydrogen usually given for one of the gases. Common errors for the other gas were oxygen and nitrogen.

(ii) Again, a large number of candidates answered this question well and ultraviolet *was* usually given for one of the regions. Common errors for the other region were X-rays and visible light, which was given in the question.

PHYSICS

Paper 0625/41
Theory (Extended)

Key messages

Candidates should be reminded to:

- learn precise definitions and include all essential details (e.g. direction in velocity, distance in light-year)
- read the questions carefully and respond exactly to the command term (state, define, describe, explain)
- round appropriately using a suitable number of significant figures to match the data they are using
- distinguish clearly between related concepts (e.g. speed vs velocity, power vs energy, mass vs weight).
- use precise scientific language rather than informal language - terms like temperature, direction, nuclei, distance, and angle of incidence cannot be omitted.

General comments

Candidates were well prepared for the examination and generally demonstrated a good understanding of topics across the physics syllabus. Many candidates demonstrated a strong understanding of fundamental concepts, including speed and velocity, force and acceleration, and the ability to perform kinetic energy calculations.

Candidates are expected to write down an equation when performing a calculation. This enables them to gain partial credit for their answer if they are unable to complete the question. This was particularly relevant in **Question 3**, where most candidates had difficulty in calculating the number of solar cells. Those candidates who quoted the equation $E = Pt$ were able to gain partial credit. More generally, candidates who showed their working in numerical questions were able to gain partial credit for correct physics when the final answer was incorrect.

Candidates should always include a unit with their final answer. Answers to **Question 6(b)(i)** were often given without a unit.

When a question involved diagrams (the force diagram in **Question 2**, the ray diagram in **Question 6** and magnetic field around a solenoid in **Question 8**), candidates who carefully constructed and clearly labelled their diagrams often gained full credit.

In some questions, candidates recalled the theory but were unable to use their knowledge to apply it to the context that was tested. For example, in **Question 7**, most candidates recalled Ohm's Law but then found it challenging to calculate the resistance of R_1 and the current in both branches. In other questions, candidates recalled the theory but then did not use precise scientific language in their answers. **Question 4(b)** and **Question 9(b)** required precise vocabulary – for example, conduction and temperature in **Question 4(b)** and nuclei in **Question 9(b)**

Candidates need to be able to define key terms clearly and precisely. In this paper gravitational field strength (**Question 2(a)**) critical angle (**Question 6(b)(ii)**), and kilowatt-hour (**Question 3(c)(ii)**) were chosen and required a clear and exact description of the syllabus concepts.

Comments on specific questions

Question 1

(a) Stronger candidates showed a clear understanding of the difference between speed and velocity, recognising that velocity has both magnitude and direction. Full credit required an explanation that included direction as an essential feature of velocity. Some candidates tried to answer by comparing the rate of change of displacement with distance, and some received full credit for this, but others produced answers that were not clear. Most candidates were able to gain credit for identifying that velocity includes direction.

(b) The strongest candidates recalled the correct kinetic energy formula and applied it accurately, squaring the velocity and giving the answer with the correct unit. However, some candidates did not remember to square the velocity even after they had written the correct formula. Some candidates also rounded their answers to only one significant figure so did not receive full credit. Most candidates gained partial credit, while weaker responses omitted the unit or made errors in powers of ten.

(c) (i) Most candidates recalled and applied the formula ***F = ma*** correctly and stated the correct unit. Only a few candidates had difficulty with the unit. Most candidates gained full or partial credit.

(ii) This question was challenging for many candidates. Stronger candidates applied the work done formula correctly, and some used a valid method beyond the syllabus. A common error was confusing time with distance, leading to incorrect calculations. Some candidates did not fully understand accelerated motion. Correct solutions either used *work done* = *force* × *distance* directly or found the time from acceleration and change in velocity, then calculated distance using average velocity. Candidates who did not use average velocity usually did not reach the correct answer.

Many candidates gave 2600 m instead of the correct 1300 m, showing a misunderstanding of average speed. Partial credit was awarded for correctly calculating the time or reaching 2600 m. Candidates needed to show understanding of the difference between constant speed and average speed.

Question 2

(a) In this question, candidates were asked to define gravitational field strength. The strongest answers defined this as force per unit mass, sometimes quoting the formula. Full credit required this precise definition. A common misconception was defining gravitational field strength as the force acting on an object.

(b)(i) In this question, candidates calculated the mass of the object from its weight on Earth and then used this to calculate its weight on Mars. Some candidates found the multistage process demanding and sometimes used the mass of Mars instead of the mass of the object. Partial credit was given for correctly applying ***W = mg***.

(ii) Most candidates recalled the density formula and were given credit for this. Some candidates found the rearrangement of the equation challenging, leading to arithmetic mistakes and errors in powers of ten. When candidates quoted their final answer for the volume of Mars, a significant proportion did not include a unit.

(c) (i) The majority of candidates drew the requested force arrow in the correct direction. Stronger answers also contained a label with the magnitude (30 N) and this gained full credit. Candidates who omitted the label but drew a correct force arrow equal in length to the driving force were also given full credit.

(ii) More successful answers contained the correct formula for the resultant force as the difference between the driving and resistive forces. Many descriptive answers or those focused on proportionality were insufficient. Common incorrect responses included "they are forces" or "they are proportional". This question highlighted the need for candidates to respond appropriately to command terms such as 'state' and 'define'.

Question 3

(a) Stronger candidates described how electrical work is done in the solar cell using light from the Sun. Full credit required a reference to the energy source and the process. Some candidates wrote answers using arrows to show a transfer of energy and this was acceptable as an alternative to writing the description in a sentence. Weaker candidates often referred to thermal energy from the Sun or used the insufficient term 'solar energy'.

(b) Most candidates correctly applied their knowledge about dull black surfaces and absorption of radiation to this unfamiliar context. Candidates needed to clearly state that black is a good absorber of radiation. The statement that black absorbs radiation was insufficient.

(c) (i) Many candidates recalled and used the equation for efficiency correctly, giving an answer in either watts or kilowatts with the correct unit. Weaker candidates sometimes had difficulty in rearranging the equation to make output power the subject. Some candidates made arithmetic errors in converting power between watts and kilowatts.

(ii) The term kilowatt-hour refers to an amount of energy or work done. Specifically, it is the energy transferred in one hour at a rate of one kilowatt. When stating the meaning of this term, candidates needed to be clear about the difference between the terms 'power' and 'energy'.

(iii) There were many ways of approaching this question and all of them required use of the equation $E=Pt$. The strongest answers included clear working. Candidates needed to convert between energy and power so that they could make a comparison. Weaker candidates often tried to compare the energy consumed in a year with the energy produced by one cell in a day. Some candidates could not use kWh in the calculation but attempted to convert to J, or confused figures for energy with those for power.

Question 4

(a) Most candidates correctly recalled and used the equation $\Delta \boldsymbol{E} = \boldsymbol{mc}\Delta\boldsymbol{\theta}$ to calculate the energy supplied to raise the temperature of the water.

(b) Stronger candidates identified that the temperature of point X on the metal rod increases more than the temperature of point X on the plastic rod. They then explained that the temperature increase is due to conduction and that the metal rod is a better conductor because it contains delocalised electrons. Some candidates explained thermal energy transfer by conduction without ever stating how the temperature at point X changes. Candidates need to read questions carefully and make sure that they answer exactly the question that is being asked.

Question 5

(a) Credit here required correct recall of the speed of sound in air and a statement that the speed of sound in water is faster. There was no requirement to state a value for the speed of sound in water, but numerical answers that showed the required understanding were accepted as an alternative to a simple statement that the speed is faster.

(b) The strongest candidates recognised that the sounds emitted by the dolphin were in the range 7kHz – 15 kHz and compared this with the normal hearing range for humans of 20 Hz – 20 000 Hz to state that humans can hear all the sounds emitted by the dolphin. A common misconception was to misread the lower end of the dolphin sounds as 7 Hz and not 7 kHz. Some candidates only gave partial explanations by explaining that all the sounds were below 20kHz and made no reference to the lower end of the human hearing range.

(c) Most candidates stated clearly that a large amplitude produces a louder sound than a small amplitude. Many candidates also stated that a frequency of 14kHz produces a higher pitched sound than a frequency of 7kHz. Almost all candidates attempted the question even if they just filled the blank boxes with the words large and small. The weakest candidates added ticks to one box in each column suggesting that they had not understood the question.

(d) Candidates were expected to complete the gaps to show that they knew it is the particles of the medium that vibrate to produce sound waves, that compressions and rarefactions refer to the regions of high and low pressure respectively and that sound waves travel parallel to the direction of the vibrations. Some candidates explained compression/rarefaction in terms of particles being closer together/further apart.

Question 6

(a) Most candidates understood that optical fibres allow faster data transmission, and many clearly stated that they are 'faster,' which gained credit. Some also correctly noted that optical fibres can carry large amounts of data. However, some candidates used less precise terms such as 'more efficient' instead of 'faster.' Many responses mentioned cost or reliability, but these were often too vague to gain credit without explanation. Answers could have been improved by using clear scientific language, for example by explaining that optical fibres are more secure or more durable, rather than making general statements about efficiency or cost.

(b) (i) This question was generally answered well, with most candidates recalling the correct equation. Those who gained full credit showed confidence in using and rearranging the equation, including correct use of the inverse sine. Others found the rearrangement of the equation challenging and gained only partial credit for writing the correct equation.

(ii) This question asked candidates to state the meaning of critical angle. Some candidates correctly linked the critical angle to an angle of refraction of 90° or to total internal reflection, and these answers were credited when this was stated clearly. The majority of answers did not mention the incident angle and used vague statements such as "the angle where refraction is 90°" or "the angle where TIR happens".

(iii) This diagram required careful constriction and labelling. Many candidates drew the first normal and reflected ray accurately, but the ray became less accurate as it travelled through the optical fibre as additional normal lines were not constructed at later reflection points. Some candidates did not label the angle of incidence, even when the first normal was drawn correctly, so otherwise good diagrams did not gain full credit. Most candidates gained partial credit for showing the ray reflecting along the fibre. When drawing ray diagrams, candidates should be reminded to carefully construct rays at the correct angles and to clearly label the angles.

Question 7

(a) Most candidates correctly used the equation $R = V/I$ and showed clear working. Many answers were either 37.5 Ω (correct) or 75 Ω, depending on whether candidates understood that the supply voltage was shared across two resistors. Overall performance was good, with many candidates gaining credit for correct recall of Ohm's Law.

(b) (i) In this question, the expected method was for candidates to recognise that the current in the lower branch was twice that in the upper branch and then to use Kirchoff's current rule to calculate the total current. In practice this method was rarely seen. The most common approach to calculate the total current was to first combine the resistances in the top branch and then use the formula $R_t = R_1R_2/(R_1+R_2)$ to find the combined resistance of the two branches. This total resistance was then used to calculate the final current. Many candidates applied the 'resistors in parallel' formula with mathematical accuracy. However, candidates should understand the importance of clearly stating what the formula is calculating, either the total resistance R_t or $1/R_t$. Without this clarity, it was sometimes difficult to award full credit, even if the numerical working was correct.

(ii) Candidates who answered this question well recognised that the full potential difference was across the single resistor, so it was greater than the potential difference across resistor R_1, which shared the supply with another resistor. They then correctly explained that a larger potential difference means more work done in the single resistor. Many candidates showed a good understanding of the link between potential difference and energy transfer. Weaker answers focused on current rather than potential difference as was directed.

Question 8

(a) (i) Many candidates gained partial credit for this question. The strongest candidates extended the field lines to include the region inside the solenoid and produced a symmetrical pattern above and below it. Full credit required four complete field lines, correctly curved around the solenoid, parallel inside, and with arrows showing the correct direction. A common error was omitting the internal field lines, which meant candidates could not be awarded the credit for parallel field lines or the credit for complete field lines. Partial credit was given for at least two correctly curved field lines outside the solenoid.

(ii) Many candidates answered this question well. The strongest candidates explained that the magnetic field is strongest where the field lines are closer together, using this precise phrasing rather than simply 'close.' Some responses were too vague to be credited.

(b) (i) This one-mark question proved challenging for many candidates. Only a few candidates correctly recalled and drew the symbol for a DC power supply. A number of candidates omitted the symbol entirely.

(ii) To achieve full credit, candidates needed to explain that the solenoid becomes a magnet, and that the soft iron arm is attracted. The strongest candidates linked the current in the solenoid to the creation of a magnetic field and recognised that the soft iron arm would be attracted to it. However, some candidates were confused by the diagram and described the bell's action using the generator effect.

(iii) To gain credit, candidates needed to correctly recognise that broken contacts meant no current would flow in the solenoid. Full credit required identifying that the circuit was broken and stating that magnetism is lost. Only the strongest candidates achieved this. Some candidates stated that a switch had opened, which did not apply to this question, and others did not explain why the solenoid lost its magnetism.

Question 9

(a) This question was generally answered well. When asked to describe the structure of an atom of Helium-4, most candidates correctly stated that this atom contained two protons and two neutrons, and many also mentioned two electrons. For full credit, candidates needed to state the location of the electrons, for example in shells outside the nucleus. Many candidates gained partial credit for identifying the protons and neutrons but did not gain full credit as the extra details they included in their answers were not relevant to the question.

(b) (i) In order to gain full credit, candidates needed to state that hydrogen nuclei fuse together to form helium. Many candidates gained credit for identifying hydrogen, but fewer correctly referred to hydrogen nuclei rather than atoms. Some answers described fusion in general without mentioning hydrogen or helium, which limited the credit that could be awarded. Most candidates gained partial credit for naming hydrogen, and some showed good knowledge of hydrogen isotopes.

(ii) This question was generally answered well. Most candidates correctly identified the relevant regions of the electromagnetic spectrum.

(c) Candidates generally displayed good knowledge of star evolution. Many correctly referred to red giants, which was the most frequently awarded marking point. Some candidates also described collapse of the core or expansion of the star and gained full credit. A common misconception was the idea that a star explodes to form giant stars, nebulae, white dwarfs, or black holes. Only a small number of candidates clearly distinguished between the different evolutionary paths for stars that become red giants or red super giants.

Question 10

(a) A few candidates did not gain any credit for this question. Some chose the wrong orbit, and others did not describe a comet's orbit correctly. Full credit required both the selection of the correct orbit and a clear description of its shape. Stronger candidates correctly stated that a comet's orbit is elliptical. Weaker answers did not use the term 'elliptical' and used vague phrases like 'stretched path,' which were insufficient.

(b) Candidates who gained full marks used precise scientific language in their answers here. Some used conservation of energy to describe and explain how the motion of the comet changes as it orbits the Sun. Others used the Sun's gravitational pull to describe and explain the motion. Stronger candidates explained that gravitational pull is stronger when the comet is closer to the Sun, causing the speed to increase. Weaker answers mentioned gravity generally without describing how it changes. Candidates who successfully used conservation of energy, correctly explained that gravitational potential energy decreases near the Sun and is converted to kinetic energy, increasing the comet's speed.

(c) (i) Performance on this question was mixed. Some candidates answered confidently and gained full credit. Weaker candidates gave an incorrect definition in terms of time, often stating that a light-year is 'a year of light' or 'the time light takes to travel in one year'. These responses showed a common misunderstanding of the term.

(ii) Candidates found this question demanding and so only stronger candidates gained full credit. A few candidates could recall the value for a light year but the calculation of a light year from first principles was rarely seen. Stronger candidates who had a value for light year used it correctly to find the distance between the comet and Earth. Some candidates gave 9.5×10^{15} as a final answer, showing they could recall the size of a light-year, but were unable to use it correctly in the calculation. A common misconception seen in weaker responses was to try to use the Hubble Constant in the calculation.

PHYSICS

Paper 0625/42
Theory (Extended)

Key messages

Candidates should always read each question carefully. They should highlight or underline key words and command words so that they answer exactly the question asked.

Candidates should take note of the command word used in a question. 'Describe' requires an answer in the context of the specific question. 'Explain' requires candidates to apply their knowledge of physics to something specific. 'Show that' requires candidates to write down the equation they will use in words or symbols followed by each step of their working to reach the final answer.

Unless there is a specific instruction in the question, numerical answers should be given to a suitable number of significant figures, which is usually two or three significant figures.

Handwriting must be legible. If an answer is changed, it should be crossed out and the new answer written in a blank space. An answer should never overwrite another answer. If an answer, or a continuation of an answer, is written at the bottom of the page or on a different page, candidates should make it clear that the answer can be found elsewhere.

When drawing a diagram, it should be drawn carefully, using a ruler where necessary.

Candidates must be careful not to round their answers too soon in calculations where there are a number of intermediate steps, as this can result in an incorrect final answer.

General comments

Candidates demonstrated a good understanding across the range of topics in the physics syllabus. Many good answers were seen in questions on motion, forces, gas pressure and electricity. Weaker answers were often seen in questions on efficiency, electromagnetism and radioactivity.

In calculation questions, most candidates showed their working clearly and usually included a unit with their answer where necessary. Candidates should always write down an equation in words or symbols before substituting in numbers and should always include the unit in their answer if it is not supplied on the answer line. This allows for partial credit to be awarded if the final answer is incorrect or if the unit is incorrect or missing.

There was evidence that some candidates struggled with unit prefixes, unit conversions and the recall of units, and would therefore have benefitted from short, regular activities to practise these.

In questions where candidates are required to show that a quantity has a particular value, or where they are asked to state the equation used, it is essential that candidates write down the relevant equation in words or symbols before substituting numbers into the equation. Manipulating numbers alone does not show sufficient understanding of the underlying physics.

Candidates should be able to define basic physics concepts in clear, precise sentences using relevant key scientific terms and phrases.

Comments on specific questions

Question 1

(a) (i) The vast majority of candidates were able to distinguish between scalar quantities and vector quantities. Some weaker candidates did not gain credit due to errors such as using the word 'distance' instead of 'direction', or stating that a scalar quantity had direction but a vector quantity did not.

(ii) Most candidates were able to identify at least two of the scalar quantities from the list. Many candidates identified all three scalar quantities but a significant number of candidates had the misconception that electric field strength is also a scalar quantity.

(b) (i) Although nearly all candidates attempted this question, a large number of candidates did not gain any credit. The question required candidates to write each stage of their working to show that the initial velocity of the tennis ball was 9.9 m / s. Candidates needed to start their answer by writing down an equation in words or symbols equating gravitational potential energy and kinetic energy. Some candidates only gave an equation in numbers which could not gain full credit as it was insufficient to demonstrate an understanding of the physics involved. It was evident that while many candidates were able to calculate the initial velocity, they often missed out some of the stages between the equation and the final answer which prevented them from gaining full credit. Candidates need to be reminded that it is essential to show each step of their working clearly in this type of question. Many weaker candidates only worked out the gravitational potential energy which did not gain credit on its own.

(ii) The majority of candidates recalled the equation for momentum and therefore proceeded to calculate the momentum of the tennis ball correctly. The most common error was to omit the unit for momentum or to give an incorrect unit. Most candidates showed their working which meant that partial credit could be awarded when the unit was omitted or incorrect. Candidates would have benefitted from short activities to practise the recall of units.

Question 2

(a) (i) The vast majority of candidates recalled the equation $F=ma$ to calculate the resultant force and gained full credit. Some candidates used the alternative equation resultant force = change in momentum per unit time. The most common error was to omit the unit for force or to give an incorrect unit but again, partial credit could often be awarded for correct working. Other errors included substituting the change in speed instead of the acceleration into the equation $F=ma$.

(ii) This question required candidates to identify two forces acting on the truck in the opposite direction to the forward force. Most candidates were able to identify at least one of these forces. Common errors included answers that were too vague, e.g. wind, or forces which act in an incorrect direction, or weight, or the use of different terms for the same force, e.g. drag and air resistance.

(b) (i) Many candidates found this question challenging and did not recognise that the force acting on an object travelling in a circular path must be perpendicular to the motion of object. Arrows were drawn in a variety of directions. Some arrows pointed towards the centre of the circle but did not start from the car, reinforcing the need for care when drawing diagrams.

(ii) Candidates found this question challenging. Answers were often too vague, e.g. "the road was too slippy" or "the car was accelerating". Candidates should be reminded of the need to use scientific terminology in their answers.

Question 3

(a) The majority of candidates were able to state the advantage that black is a good absorber and gained credit for this. Far fewer candidates were able to explain that this would result in more electricity being generated or the solar panels being more efficient.

(b) This question required candidates to rearrange the equation for efficiency in order to calculate the total power input to the solar panels. Although many candidates could recall the equation, only stronger candidates were able to manipulate the equation correctly to gain full credit. The most common errors included not using the correct terms in the equation, i.e. just power output instead of useful power output, and misinterpreting the data given in the question, i.e. using 3.5 kW as the total power input instead of the useful power output. Some candidates also stated the unit as joules or had power of 10 errors due to using 16 instead of 0.16 or 16 per cent as the efficiency.

(c) Many candidates had difficulty in giving a clear difference between alternating current and direct current. A significant number of answers were too vague, e.g. "a.c. is in different directions". Candidates should be encouraged to use more precise scientific language in their answers.

(d) Candidates found it difficult to suggest an advantage of storing energy in the rechargeable battery. Common incorrect answers included the idea that energy would not be wasted or that lots of energy could be stored as the battery was large.

(e) The vast majority of candidates were able to state the correct equation to calculate charge flow. Most stronger candidates gained full credit. However, weaker candidates found the conversion of time from hours to seconds challenging or did not know the correct unit for charge.

Question 4

(a) (i) The majority of candidates were able to apply the equation $pV = constant$ to calculate the volume of the gas when the piston was at its new position. The most common error was to use an incorrect equation of the form: $\frac{P_1}{V_1} = \frac{P_2}{v_2}$

(ii) Most candidates gained at least partial credit for identifying the equation $P = \frac{F}{A}$ to calculate the force exerted on the piston. The most common error made was to rearrange this equation incorrectly.

(iii) Candidates were instructed to state the equation, in words or symbols, for mechanical work done before proceeding to calculate the work done. Although most candidates followed this instruction, those who did not state the equation could not gain any credit.

(b) Although candidates demonstrated good knowledge of particle structure, many candidates could not clearly explain why gases can be compressed but liquids cannot. Many incorrect answers focussed on ideas about the random movement of gas particles or did not give a clear comparison of the distance between particles in gases and particles in liquids.

Question 5

(a) (i) Many candidates gained at least partial credit for this question about evaporation. It was evident that candidates had a general understanding that particles gain energy from the Sun and this energy affected their movement. However, a significant number of candidates did not gain credit as their descriptions only included vague ideas about particles moving faster, vibrating more or moving further apart, and did not reference the more-energetic particles escaping from the surface of the water. Another error made by some candidates was to confuse evaporation with convection.

(ii) This question was attempted well with the majority of candidates gaining at least partial credit, usually for the idea of the weather becoming warmer. Fewer candidates were able to explain why their chosen change in weather would increase the rate of evaporation, especially if their chosen change referred to the wind.

(b) Only the strongest candidates answered this question about braking distance well. One of the main issues appeared to be that candidates did not read the question carefully enough so did not realise that they had to both state and explain how braking distance changes when the road is wet. Candidates should be encouraged to underline or highlight command words, especially if there are two command words in the same question. Another common error involved unclear language where candidates stated that the braking distance would take longer rather than the braking distance being longer.

Question 6

(a) (i) This question assessed candidates' knowledge of refraction and its application to the example in the diagram. The majority of candidates were awarded at least partial credit, usually for drawing wavefronts in region B which joined at the boundary with the wavefronts in region A. However, most candidates demonstrated a poor understanding of the direction in which the wave refracted when it entered the region where it travelled more slowly which limited the credit that could be awarded.

(ii) A significant number of candidates did not know the term for this wave effect. There were also a number of candidates who mixed up the term with rarefaction.

(b) (i) Stronger candidates gained full credit for correctly explaining that when light travels from a more dense to a less dense medium, total internal reflection occurs if the angle of incidence exceeds the critical angle. Some candidates recognised the need to relate the incidence angle to the critical angle and the change in density but described the conditions incorrectly or in reverse. Common misconceptions involved the angle of incidence needing to be equal to the angle of reflection confusing TIR with reflection from a plane surface.

(ii) This question was not answered well, and candidates demonstrated a poor understanding of the advantages of using optical fibres for transmitting high speed broadband. Most candidates gave answers that were too vague. For example, cheaper, faster or more efficient were not credited, and any mention of fibre transparency needed to specify transparency to infrared or visible light. 'Faster rate of transmission' was also too vague but could have been awarded credit if reference to transmission of data was made.

Question 7

(a) This question required candidates to draw a circuit diagram using only the components listed. The vast majority of candidates gained at least partial credit, but weaker candidates were unable to recall the correct symbols, especially for an a.c. supply. Drawing the components in parallel was more successfully attempted. Common errors included incorrect circuit symbols, additional circuit symbols added to the diagram and an extra wire drawn in parallel to the lamps.

(b) (i) The vast majority of candidates recalled and correctly rearranged the equation to calculate the current in the lamp. Some common errors included the incorrect use of 1200 Ω or 2000 Ω as the value of the resistance in the equation, incorrect rearrangement of the equation, and giving the final answer to only one significant figure. By showing all of the working, including the equation in symbols, most candidates who made these errors were able to gain partial credit.

(ii) Stronger candidates performed well on this question and gained full credit. Weaker candidates were unable to identify which equation was required and worked out a range of quantities such as power from $P=IV$. If these candidates had then used $E = Pt$, they could have reached the correct final answer. Candidates should be reminded that is important not to round intermediate answers as it is likely that by doing so, their final answer will not be correct to two significant figures. Many candidates gained partial credit by dividing their calculated value of energy by 1000.

(iii) Here candidates who knew the correct equation to determine the combined resistance of resistors in parallel answered well. Most weaker candidates treated the resistors as if they were in series and simply added the resistances. Other common errors included quoting an incorrect equation, e.g. $R_T = \frac{1}{R_1} + \frac{1}{R_2}$, or using the correct equation but forgetting to find the reciprocal at the end, or problems with adding fractions.

Question 8

(a) Candidates found it challenging to recall what was meant by a magnetic field. Common errors included answers that referred to magnetic objects/materials or charge instead of pole.

(b) (i) Few candidates answered this question correctly. Most correct answers were in terms of the friction between the trolley and the track as attempts to answer in terms of the induced current opposing the magnetic field that causes it were too vague. Friction was often mentioned in answers but candidates were not explicit about between which objects friction acted so these answers did not gain credit. Other incorrect answers included ideas about air resistance and the transfer of gravitational potential energy to kinetic energy. Candidates should note that when giving an answer which refers to friction, they should be explicit about between which surfaces/objects friction acts.

(ii) Candidates found this question very challenging with only stronger candidates answering fully correctly. The majority of candidates gained credit for describing the direction of the deflection on the ammeter. Some candidates worked out that the deflection would be smaller but had difficulty in linking this to a smaller induced current.

Question 9

(a) This question assessed candidates' knowledge of the path of alpha particles, beta particles and gamma radiation in a uniform magnetic field. The majority of candidates were able to draw the correct path of gamma radiation but only stronger candidates were successful at drawing the correct paths of alpha particles and beta particles. The vast majority of candidates appeared to know that alpha particles and beta particles followed curved paths in the field but, had difficulty in drawing the paths carefully enough or the curves were not always in the correct direction. Other common errors included the paths not being a continuation of the beam entering the field, the paths reversing direction, the paths not starting to curve soon enough and the paths stopping before reaching the end of the field.

(b) (i) Although the majority of candidates knew that half-life is an amount of time and related to how fast a radioactive sample decays, the lack of precise terminology meant that most candidates did not gain credit. Candidates need to note that the idea of half-life being the time taken for half of the sample to decay was insufficient and more specific detail was needed, e.g. the time taken for half of the nuclei to decay or the time taken for the activity to halve.

(ii) This question required candidates to identify the most suitable radioactive source to use to measure the thickness of aluminium sheets. Most candidates found the question very challenging with a significant number of candidates not gaining credit. Although many candidates knew that the source had to be a beta emitter, the question asked candidates to state a suitable source from **Table 9.1**. Candidates appeared not to have read the question carefully enough, instead opting to give beta (or alpha or gamma) as the most suitable source. The most commonly awarded credit was for the fourth marking point but, many candidates did not express it clearly enough, e.g. 'alpha is too weak' or 'alpha can only penetrate paper' instead of 'alpha cannot penetrate aluminium'.

Question 10

(a) This question about the accretion model was answered well by many stronger candidates. Weaker candidates mostly recalled that the planets nearest the Sun are rocky and those furthest from the Sun are gaseous but common incorrect answers for these were hot and cold. Least well known was that the rotation of material in the cloud forms an accretion disc.

(b) The vast majority of candidates gained at least partial credit as they recalled and correctly rearranged the equation to use with their value of the speed of light to calculate the distance of the Moon from the Earth. A common error made by weaker candidates was incorrectly rearranging the equation. Some candidates were unable to recall the value of the speed of light but, partial credit was awarded based on the use of the candidates' value of the speed of light in the correct equation.

(c) Candidates found this question very challenging with only stronger candidates able to correctly recall and manipulate the equation $H_0 = \frac{v}{d}$, as well as the value of a light-year. Alternatively, candidates who did not remember the value of a light-year were given credit for showing the calculation to derive its value. Common errors involved recalling the equation or rearranging it incorrectly, and an incorrect or missing conversion of light-years to metres.

PHYSICS

Paper 0625/43
Theory (Extended)

Key messages

Candidates should always read each question carefully, taking note of information in the question and on diagrams. Candidates should ensure they answer the question being asked and use key terminology in explanations.

In questions where knowledge is being applied, it is important that candidates select the most relevant physics and apply it to the context. If an answer includes a diagram, it is important to label the diagram clearly.

When taking numerical data from graphs, candidates should check they have accurately read the value from the graph and noted any unit included on the graph scales.

General comments

Candidates demonstrated a good understanding across the range of topics in the physics syllabus. Candidates gave good responses to questions on motion, waves, the Universe and space. Weaker answers were often seen in questions on energy, electric circuits, and electromagnetic effects.

Many candidates showed their working in calculation questions and usually included the unit with their answer. Candidates benefit from writing down an equation before substituting in numbers and should always include the unit in their answer.

Candidates should be able to define basic physics concepts in clear, precise sentences or using equations as appropriate.

Comments on specific questions

Question 1

(a) (i) Many candidates correctly described the motion of the ball from the speed-time graph. Some candidates only stated acceleration in their response and did not identify constant acceleration.

(ii) Stronger candidates stated the relationship between distance travelled and area under the graph and substituted values read from the graph accurately. Weaker candidates gave only a substitution without an equation or did not read values carefully from the graph.

(iii) The majority of candidates were able to correctly recall and use $Ep = mgh$ to give the correct answer. Some weaker candidates omitted the unit from their answer or gave an incorrect answer unit.

(iv) Stronger candidates recognised the kinetic energy would be half of the gravitational potential energy when the ball had fallen half the distance.

(b) Many candidates were able to identify the forces acting on the ball. Stronger candidates were able to clearly explain the change in motion of the ball as the speed increased causing the air resistance to increase. Weaker candidates often incorrectly stated that the acceleration of the ball increased or stated the ball slowed down. Some candidates incorrectly described acceleration as a force that would equal weight at terminal velocity.

(c) The strongest candidates explained the change in height of the ball clearly stating the correct energy store and the transfer of thermal energy to the ground or air. Weaker candidates described the change in the energy stores of the ball as it moved from A to B without explaining the change in height.

Question 2

(a) The majority of candidates were able to correctly recall and use $p = mu$ in words or symbols to calculate the momentum of the ball. Some candidates gave an incorrect unit with their answer.

(b) Many candidates were able to recall and use $F = p / t$ with stronger candidates able to convert milliseconds to seconds to give a correct answer. Weaker candidates attempted to use $F = ma$ without calculating acceleration and substituting the value for time instead.

Question 3

(a) (i) The majority of candidates clearly showed a correct calculation and provided an answer to at least three significant figures.

(ii) Most candidates calculated the efficiency of the power station and gave a correct answer as a percentage. A few candidates gave an answer as a decimal value and incorrectly included a unit with their value.

(b) Stronger candidates were able to describe how useful energy can be obtained from geothermal resources. Weaker candidates were able to describe steam being used to turn turbines to generate electricity but were unable to identify the process by which steam is produced.

Question 4

(a) (i) Many candidates were able to calculate the density of the liquid. Some candidates omitted to include a unit or gave an incorrect unit.

(ii) Stronger candidates were able to calculate the force exerted and included a correct unit with their answer. Weaker candidates were often able to calculate the area and recall $p = F / A$ but were unable to calculate the pressure due to the water.

(b) Many candidates recognised that the rails would expand when heated and stronger candidates were able to explain the expansion in terms of particle movement. Weaker candidates incorrectly referred to particles expanding rather than increased separation between particles.

(c) Most candidates stated that plastic is an insulator or a poor conductor and were able to explain why this was suitable.

Question 5

(a) (i) The majority of candidates correctly linked all uses to regions of the e-m spectrum. Weaker candidates often linked security marking to infrared and optical fibres to ultraviolet.

(ii) The strongest candidates recalled a correct advantage of microwaves compared to radio waves for phone signals. Weaker candidates often stated a property of microwaves compared to radio waves not linked to an advantage.

(b) Stronger candidates gave clear descriptions of the differences between transverse and longitudinal waves using the correct terminology. Some candidates did not refer to oscillations when giving a definition of a transverse or longitudinal wave.

(c) (i) Many candidates correctly gave longitudinal as the answer here.

(ii) Many candidates recognised the density of the medium changed as the wave crossed the boundary or the speed of the wave changed. Stronger candidates gave the process as refraction.

(d) Stronger candidates gave a clear explanation linking an increase in greenhouse gases and the amount of radiation that is prevented from escaping the atmosphere. Weaker candidates recognised greenhouse gases prevent thermal radiation leaving the atmosphere but did not explain why the average temperature is rising.

Question 6

(a) (i) The majority of candidates recalled $V = IR$ with stronger candidates correctly using the voltage across the resistor. Some candidates instead substituted the voltage across the LDR or incorrectly rearranged the equation leading to an incorrect value.

(ii) The strongest candidates explained the effect on the voltmeter reading correctly recognising the resistance of the LDR would increase. Weaker candidates misunderstood the operation of an LDR stating it would stop working in the dark due to lack of energy, or that the LDR resistance would decrease in darker conditions.

(b) (i) Many candidates correctly used the graph to give at least one correct current value. Some candidates gave a unit of amps instead of milliamps without converting their value. Weaker candidates attempted to calculate an answer using $V = IR$.

(ii) Stronger candidates recalled the operation of a light-emitting diode and consequently identified that the current would be zero.

Question 7

(a) (i) The strongest candidates recalled the function of slip rings and brushes and gave a clear description. Weaker candidates referred to the brushes supplying current to the coil.

(ii) Many candidates described the motion of the coil relative to the magnetic field and the coil cutting the magnetic field, with stronger candidates continuing to describe an induced e.m.f. or the direction of the current reversing every half turn. Some candidates described a motor that is supplied with current not how a generator produces an alternating current.

(iii) Many candidates stated that the coil should be rotated faster or that a coil with more turns should be used. Some candidates suggested a change of magnetic field strength but did not specify the strength should be increased.

(b) (i) Many candidates identified the correct number of revolutions. Some candidates misunderstood the graph stating five revolutions.

(ii) Candidates needed to recognise the position of the coil and the e.m.f. produced with some positions in the question unused. Many candidates were able to identify one or two correct positions, and a few candidates drew one line to each coil position.

Question 8

(a) (i) Many candidates gave a correct conclusion. Weaker candidates stated the foil, or the nucleus contains empty space and did not refer to the atoms.

(ii) Stronger candidates gave a conclusion about the nucleus, often referring to the positive charge. Some candidates recognised the path of the alpha particle changed because of the nucleus, without giving the property of the nucleus that caused it to deflect.

(b) (i) The strongest answers identified the correct path and gave an explanation linking the mass of the alpha particle to less deflection. Weaker candidates often selected path R recognising the path would deflect.

(ii) To gain credit candidates needed to identify the direction of the electric field and give an explanation linking to the charge of an alpha particle. The strongest candidates were able to give all of these points.

(c) Many candidates gave a correct answer and included a unit with their answer. Stronger candidates showed clear working stating three half-lives.

Question 9

(a) (i) The majority of candidates gave a correct answer. A common error was to state it was produced in a supernova or when new stars are formed.

(ii) Many candidates recalled that the wavelength had increased and stronger candidates were able to provide an explanation, commonly referring to the expansion of the Universe.

(b) (i) Many candidates were able to recall and use $v = 2\pi r / t$ to give a correct answer. Some candidates selected data for the correct planet without considering the information in the column heading and gave an incorrect answer.

(ii) The majority of candidates gave a correct answer. Some candidates gave an explanation for temperature being lower without stating that the temperature would decrease.

Question 10

(a) The majority of candidate diagrams showed an elliptical orbit, often with the Sun placed clearly at a focus. Weaker candidates placed the Sun approximately in the centre of their orbit or drew a circular orbit.

(b) Many candidates placed a labelled cross in a correct position for their orbit.

(c) Stronger candidates were able to give a clear explanation with a correct change in energy stores linked to change in speed. The strongest candidates recalled the conservation of energy and clearly explained that the total energy in the system would remain constant during the orbit. Weaker candidates stated the comet had more gravitational potential energy when moving faster.

SYLLABUS NAME

Paper 0625/51
Practical Test

Key messages

- Candidates need to have had a thorough understanding of practical work during the course, including reflection and discussion on the techniques used 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 sensible use of significant figures and correct units 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 clearly had regular experience of similar practical work and much less successfully by those who, apparently, had not.

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

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

Comments on specific questions

Question 1

(a) Candidates were expected to give the value of *y* to the nearest mm, i.e. 40.0 cm. Some candidates measured the distance on **Figure 1.1** instead of correctly using the information in the question.

(b) Most candidates obtained a realistic *x* value and calculated the weight *W* correctly. Candidates were expected to give the weight to two or three significant figures.

(c) Many candidates completed this successfully and achieve a value of *W* which was within 10 per cent of the previous value obtained in **(b)**. Some candidates obtained an unrealistic value for the distance *x*.

(d) Candidates were expected to write a statement that matched their results with an explanation of why the two *W* values could or could not be regarded as equal within the limits of experimental accuracy. For example, if the results were similar, the candidate could comment that they were within 10 per cent of each other, or very close to each other. A significant number of candidates calculated the percentage difference between the two values.

(e) Here candidates needed to address the problem that the load hides the 90.0 cm mark on the metre ruler. For example, candidates could show by diagram or wording that the edges of the object Q could be placed symmetrically either side of the 90.0 cm mark.

(f) Candidates were expected to explain taking repeat readings and averaging or moving the load slowly back and forth to find the best position.

Question 2

(a) Most candidates recorded a realistic value for current, given to at least 2 decimal places.

(b) (c) Most candidates completed the table successfully although a significant number did not fill in the column headings. Candidates were expected to give the potential difference values to at least one decimal place. Most followed the instructions and obtained increasing values for potential difference as the length *d* was increased. The resistance values were expected to be given to a consistent three significant figures or a consistent four significant figures.

(d) Most candidates labelled the graph axes correctly and drew them the right way round. Plotting was generally accurate. Candidates should use neat crosses for the plots, or neatly circled dots so that the accuracy of the plotting is clear. Most candidates obtained a realistic set of readings that resulted in plots producing a good straight line. However, some candidates drew a straight line that did not match the plots or a series of straight lines joining each plot to the next.

Question 3

(a) Most candidates drew a neat diagram with the normal correctly positioned 2.0 cm from A.

(b) Most candidates correctly drew the angle of incidence at 30°. Candidates were expected to show a pin separation of at least 5 cm. A significant number of candidates placed the pins too close to each other. The refracted ray was drawn correctly by many candidates.

(c) The angle θ was measured correctly by many candidates. Initial credit was for correct measurement of angle. Further credit was for obtaining a value within 2° of 30°, indicating a carefully carried out experiment.

(d) Candidates were expected to follow the instructions carefully and many did so, resulting in the rays being neatly drawn in the correct quadrants.

(e) Candidates were expected to realise that the pins should be placed more than 5.0 cm apart.

(f) Candidates were expected to suggest at least two extra values for the angle of incidence with a range spread over at least 30°.

Question 4

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

A concise explanation of the method was required. Candidates needed to concentrate on the readings that had to be taken and the essentials of the investigation. It may benefit candidates to plan their table of readings before writing the method to help them to think through the measurements that are required in order to address the subject of the investigation.

In this investigation candidates had to plan an experiment to test whether or not five 12 V heaters, all with the same power rating, were of equal efficiency. The investigation was not to find which was the most efficient.

Candidates needed to realise that a timer and a thermometer would be required.

For the method, candidates needed to measure the time taken to heat water to boiling point with one of the heaters and then to repeat this with the other heaters. A vague reference to repeating was not sufficient as it was not clear whether the heater had been changed.

The two most significant variables to keep constant were the initial temperature of the water and the volume of water.

Many candidates drew a suitable table. They were expected to include columns for the heater, and time with the units.

Candidates were expected to explain how to reach a conclusion by drawing a bar graph of the time against heater, or by comparing values from the table to see whether the heater affects the time for the water to reach boiling point. 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 understanding of practical work during the course. Candidates should have as much personal experience of carrying out experiments themselves, as possible. The practical work should include reflection and discussion of the significance of results, precautions taken to improve reliability and control of variables.

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

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

Many candidates were unable to derive conclusions backed up by evidence, or to present well thought out conclusions.

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

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques. 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 within the limits of experimental accuracy
- dealing with possible sources of inaccuracy
- control of variables.

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 every practical test were attempted and there was no evidence of candidates being short of time. The majority of candidates were able to follow instructions, record observations clearly and perform calculations accurately and correctly.

Comments on specific questions

Question 1

(a) The normal to the line **LN** was almost always drawn correctly and extended downwards to cross the line **PR**, which was almost always drawn parallel to **LN** and 12.0 cm below it. A tolerance of ± 0.1 cm was allowed here. Occasionally, the point at which the normal crossed the line **PR** was not labelled with the letter **Q**, as requested in the question.

(b) The line **MO** was usually drawn in the correct position at an angle of 10° to the normal, as specified. A tolerance of ± 1° was allowed here, but careless use of the protractor meant that some candidates were outside this allowance.

(c) The majority of candidates marked two crosses on the reflected ray, but on many ray traces, the crosses were too close together. It is good experimental practice when marking crosses to define the path of the reflected ray, to make the distance between these crosses at least 5.0 cm.

(d) The lengths *a* and *b* of lines **QT** and **MT** were measured within the allowed tolerance of ± 0.1 cm by the majority of candidates. Despite the instruction to measure *a* and *b* to the nearest millimetre, a few candidates recorded their answers to too few, or too many significant figures.

(e) The majority of candidates repeated the procedure for angles of incidence of 20° and 30° and recorded a full set of results for the experiment.

(f) The concept of direct proportion was only understood by a small percentage of stronger candidates. Most candidates were able to look at the 3 values of θ and the three values of r in the table and, write down a matching correct statement – that r is/is not directly proportional to θ. Their justification for saying this was almost always incorrect. The most common incorrect answer was that r is directly proportional to θ because as θ increases r increases. The strongest candidates gained credit here either by finding the ratio of r / θ for all 3 values of r and θ and showing that this gave a constant value, or by showing that doubling r, doubled θ and trebling r, trebled θ.

(g) A majority of candidates understood what needed to be done to increase confidence in the answer to **(f)**. Most realised that the investigation should be extended for additional different values of θ. A very common incorrect answer was to repeat and average using the same values of r and θ as before.

(h) Many candidates were able to suggest a valid source of inaccuracy in the experiment. The most common correct answers were that the ray of light has a finite thickness, so it is difficult to locate its centre, that the mirror is thick and its reflecting surface is at the back, and that the experiment was not done in a dark room.

Question 2

(a) The reading on the voltmeter V_0 was almost always present and recorded to a precision of 0.1 V, or better.

(b) The reading on the voltmeter V when the 10Ω resistor was connected between points X and Y was usually recorded in the table. In most cases, the value recorded was $< V_0$, which was to be expected.

(c) The majority of candidates repeated the procedure in **(b)** for the other resistors provided, and obtained a full set of results. Most tables displayed the correct trend, namely that the V values increased as the value of the resistor connected between points X and Y increased.

(d) Candidates were required to use the data recorded in their tables to deduce the current I in the circuit when each of the resistors was connected between points X and Y. Calculations were usually correct, but once again, many candidates ignored the instruction to record the value of the current I to 2 significant figures.

(e) The graph axes were almost always labelled and the correct way around. 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 and more difficult for plotted points to be checked. Point-plotting was accurate, with most candidates placing their dot or cross within one-half of a small graph square of the exact location of the point.

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

(f) As expected, candidates who drew a large triangle to determine the gradient *G* of their graphs obtained the most accurate values for the gradient of the line. However, in some cases there was no clear indication on the graph of how the information to determine the gradient had been obtained, despite the instruction being given to do so.

(g) Candidates were told that the gradient *G* of their line was numerically equal to the resistance of the unknown resistor and asked to write down the value of the resistance to the nearest ohm. Candidates often ignored this instruction and did not round their value of *G* to the nearest integer.

Question 3

(a) All candidates recorded a sensible value for the room temperature. Values seen ranged from 18°C to 30°C.

(b) (i) The majority of candidates followed the instructions given, and recorded the temperature of the hot water cooling at 1 minute intervals for 5 minutes. Most results tables were complete, and displayed the expected trend, namely that the temperatures decreased as the time of cooling increased.

(ii) The reason for waiting for 30 s before measuring the initial temperature of the hot water was to allow the thermometer to record the highest temperature reached, or to give the thermometric liquid time to expand. Many candidates thought that it was to allow time for the temperature to become constant, which was unlikely in the context of this experiment.

(iii) Many candidates misinterpreted what was required here, namely how accurate temperatures of the cooling water are obtained during the experiment. Creditworthy answers referred to perpendicular viewing of the thermometer scale, stirring the water before taking a reading, ensuring that the thermometer does not touch the sides of the beaker etc. Many responses were related to the accuracy of the final result or to improvements to the experiment. Irrelevant answers such as suggestions to repeat and average or to keep the room temperature constant were common.

(c) The calculation of the average rates of cooling of the water over the first and the final two minutes of the experiment was done well. There were occasional rounding errors and answers being left as fractions.

(d) The majority of candidates succeeded in using the initial and final cooling rates calculated in **(c)** to write a satisfactory conclusion which described the way in which hot water in a beaker cools. Most candidates correctly deduced that the cooling rate of hot water decreases (with temperature/time).

(e) (i) This more demanding final part of the question proved to be challenging for many candidates. Candidates were asked to estimate the temperature of the water after cooling for a further 5 minutes. Having deduced in **(d)**, that the rate of cooling decreases with time, it was expected that candidates would realise that the temperature decrease in a further 5 minutes would be less than the temperature decrease in the first 5 minutes. Any value of final temperature which showed a smaller decrease in temperature of the water over the second 5 minute cooling interval was accepted here.

(ii) Many candidates correctly predicted the temperature of the water after a further 50 minutes of cooling. A majority realised that the water would have cooled down to room temperature or very close to it. A range of temperatures within ± 2°C of candidates' measured value for the room temperature in **(a)** was accepted.

Question 4

Initial credit was available for candidates stating the one variable that they had chosen to investigate. The variable needed to be clearly stated to obtain credit, and not just implied in the method, table or analysis and left for interpretation. The most popular variable chosen was the mass of the ball. Other acceptable variables seen were diameter of ball/height of release/separation of the retort stands.

Further credit was available for stating any other apparatus, apart from the apparatus listed in the question, that they would need to do the experiment. Most candidates realised that they would also need a ruler, but many candidates omitted to state any additional apparatus they would need to measure their chosen independent variable – if not height of release or diameter of ball, where a ruler would suffice.

Credit was then awarded for giving a brief explanation of how the investigation would be carried out. Most candidates first measured the independent variable and released the ball and then measured the height *h* and repeated for a new value of the independent variable.

Candidates had little trouble in suggesting a key variable to control during the experiment. Any significant control variable appropriate to the independent variable was acceptable.

Most candidates drew an acceptable table of results with clear columns with appropriate units for their chosen independent variable, and the dependent variable *h*.

Fewer candidates explained satisfactorily how they would use their results to reach a conclusion, because they made predictions about the outcome. An answer suggesting they should compare the results to see if/how/whether the mass/diameter/height of release of the ball affects the height *h*, was all that is required. Many stronger candidates also suggested plotting a graph of mass/diameter/height of release against *h*.

PHYSICS

Paper 0625/53
Practical Test

Key messages

Candidates who were successful on this paper showed evidence of having performed a wide range of practical work in the classroom. They knew the apparatus and could describe its use in detail. They analysed data carefully and drew appropriate conclusions. They were able to write plans for experiments detailing steps logically and then followed their plans so they could reflect upon the quality of their explanations.

General comments

Candidates showed an excellent knowledge of the experiments included in the paper including the methods and the apparatus. They were able to use the equipment provided and follow written instructions to make accurate measurements, analyse data, form conclusions and critically evaluate their work.

Candidates should ensure that they record data to the resolution of the measuring instrument, e.g. measurements with a ruler with mm markings must be recorded to the nearest mm so 15.0 cm was appropriate, and 15 cm was not appropriate. In both **Questions 2** and **3** it was clear that some candidates did not follow the instructions given leading them to incorrect answers or data recorded.

Comments on specific questions

Question 1

(a) (i) All candidates measured three dimensions of their modelling clay. A few did not record all their measurements to the nearest mm.

(ii) Most candidates calculated the volume of their modelling clay correctly.

(b) Many answers focused on the resolution of the ruler used. The most significant source of inaccuracy was that the block of modelling clay had irregular dimensions. Those who identified this as the source of inaccuracy often suggested that the improvement was to repeat the measurements. However, they did not state the need to take these repeats in different places along the block for each dimension and then find the mean.

(c) Many responses focused on it being difficult to measure small objects or errors being more likely, without going into any further detail. The correct answer focused on the fact that when taking smaller measurements, the effect of the uncertainty in the measurement (due to the resolution of the measuring device) is greater. There is a larger percentage uncertainty in smaller measurements.

(d) (i) All candidates recorded appropriate values for the volume.

(ii) All candidates made a correct calculation. The volumes measured by displacement were often significantly larger than those calculated in **(a)(ii)**.

(iii) This was usually drawn correctly with a horizontal arrow at the bottom of the meniscus.

(e) Some candidates identified that the volume of the thread might affect the result or that the graduations on the measuring cylinder were large. A significant number of candidates tried to repeat the physics tested in **(d)(iii)**. Not reading from the bottom of the meniscus would be associated with poor experimental practice.

Question 2

(a)(b)(c) All candidates recorded three values for potential difference and current. In some responses, they were not recorded to a consistent number of decimal places (i.e. not to the resolution of the meter).

(d) Most candidates followed the written instructions to calculate resistance. In some cases a consistent number of significant figures was not used. Occasionally candidates entered the answers for **(e)(i)** in their table.

(e) (i) Most candidates followed the written instructions to state or calculate these resistances. Some candidates copied values from their table.

(ii) Most candidates were able to state that their values were close enough or within experimental accuracy. Stronger answers showed a calculation of the percentage difference or statement relating to 10% to reinforce their statement.

(f) Many answers referred to a fair test. The fixed resistor was included to limit the current in the circuit/prevent significant heating of the wire. This was recognised by a small number of candidates.

Question 3

(a) (i) Almost all candidates recorded a value for h_o. Some omitted the technique. There were many references to moving the screen or the lens. However, relatively few candidates referred to moving the screen back and forth or slowly.

(ii) Almost all candidates recorded 5 values for h_I.

(b) Almost all candidates calculated D values. Some answers were given to only 1 significant figure.

(c) Almost all candidates labelled axes correctly. Some scales did not begin from the origin as instructed. Points were generally well plotted. Candidates should be encouraged to plot using thin crosses rather than large circular blobs. Most lines of best fit were appropriate and had a balance of points on each side of the line. A few candidates joined the dots. Some forced their line through the origin rather than recognising and reflecting the trend in the data.

(d) (i) Most candidates correctly read the intercept from their line. Those who did not start their scale at the origin generally struggled to give the correct intercept for their line.

(ii) Most candidates showed correct working and found a suitable answer for the gradient. A small but significant number of candidates tried to calculate a gradient by referring to the number of 2 mm squares on the graph paper rather than using their axis scale.

(iii) Generally, most candidates were in range.

(e) Candidates found it challenging to identify a suitable difficulty and give an appropriate improvement.

Question 4

Marking point 1: Candidates often repeated the list of available apparatus. Some candidates identified that a measuring cylinder or balance was required. Many referred to a scale (rather than (weighting) scales) which is what is printed on, for example, a ruler. This cannot be used to measure mass. Many candidates omitted the ruler which was required to measure the diameter of the dish.

Marking point 2: The majority of candidates explained how to do the experiment well.

Marking point 3: Most candidates referred to repeating the measurements. In some responses, this was not clear as candidates referred to performing the experiment on five dishes all at the same time.

Marking point 4: Candidates were very strong on identifying control variables and most identified at least two.

Marking point 5: Candidates needed to note that this was a results table. This meant that any measurements they made should have been recorded in this table. Not all candidates drew a table or referred to column headings. Many candidates omitted the units.

Marking point 6: The most common way to score credit here was to draw a graph with the axes stated, not just suggesting ‘draw a graph of the results’. Another way was to say ‘look at the results and see if the mass evaporated changes as the diameter increases’. Some candidates gave a prediction instead of a conclusion e.g. “as the diameter increases the mass evaporated will increase” and so did not score credit here. Many successful candidates seemed to have been taught a pattern: ‘plot a graph of the dependent variable against the independent variable, see if changing the independent variable affects the dependent variable’.

Marking point 7: There were various ways of gaining credit here. The most common was to use at least five different diameters, or to state a second control variable. Some candidates made the mistake of stating ‘repeat the experiment and take the average’ when they should have written ‘repeat the readings for each length and take the average’.

PHYSICS

Paper 0625/61
Alternative to Practical

Key messages

- Candidates need to have had a thorough understanding of practical work during the course, including reflection and discussion on the techniques used 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 sensible use of significant figures and correct units 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 clearly had regular experience of similar practical work and much less successfully by those who, apparently, had not. Some candidates appear to have learned sections from the mark schemes of past papers and written responses that were not appropriate to the questions in front of them.

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

It is expected that numerical answers will be expressed to a number of significant figures which is appropriate to the data given in the question.

Comments on specific questions

Question 1

(a) Candidates were expected to give the value of *y* to the nearest mm, i.e. 40.0 cm. Some candidates measured the distance on **Figure 1.1** instead of correctly using the information in the question.

(b) Most candidates calculated both values for the weight W correctly. Candidates were expected to give the weights to two or three significant figures.

(c) Candidates were expected to write a statement that matched their results with an explanation of why the two W values could or could not be regarded as equal within the limits of experimental accuracy. For example, if the results were similar, the candidate could comment that they were within 10 per cent of each other, or very close to each other. A significant number of candidates calculated the percentage difference between the two values.

(d) Here candidates needed to address the problem that the load hides the 90.0 cm mark on the metre ruler. For example, candidates could show by diagram or wording that the edges of the object Q could be placed symmetrically either side of the 90.0 cm mark.

(e) Candidates were expected to explain taking repeat readings and averaging or moving the load slowly back and forth to find the best position.

(f) Most candidates correctly calculated the distance d. Some did not show the working as requested in the question.

Question 2

(a) Most candidates recorded the current correctly.

(b) Most candidates completed the table successfully, but a significant number did not fill in the column headings.

(c) Most candidates labelled the graph axes correctly and drew them the right way round. 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. Most candidates obtained a realistic set of readings that resulted in plots producing a good straight line. However, some candidates drew a straight line that did not match the plots or a series of straight lines joining each plot to the next.

(d) Candidates were expected to clearly show the method for reading off the graph and most did this. The reading from the graph was usually completed successfully. Candidates who had drawn an accurate graph with a well-judged straight line obtained a value for R_{75} that was within the tolerance allowed.

Question 3

(a) Most candidates drew a neat diagram with the normal correctly positioned 2.0 cm from A.

(b) Most candidates correctly drew the angle of incidence at 30°. Candidates were expected to show a pin separation of at least 5 cm. A significant number placed the pins too close to each other.

(c) The refracted ray was drawn correctly by many candidates, resulting in an accurate value for the angle r. The angle θ was measured correctly by many candidates. Initial credit was awarded for careful drawing of the line through P3 and P4, continued to meet the normal. Further credit was given for a value within 2° of 30°, indicating a carefully carried out experiment.

(d) (i) Candidates were expected to realise that the pins should be placed more than 5.0 cm apart.

(ii) Candidates should be aware from their experience of practical work, that drawing thin lines (using a sharp pencil) and viewing the bases of the pins (easier than ensuring that the pins are vertical) are techniques to use to produce an accurate ray-trace.

(e) Candidates were expected to suggest at least three extra values for the angle of incidence with a range spread over at least 30°.

Question 4

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

A concise explanation of the method was required. Candidates needed to concentrate on the readings that had to be taken and the essentials of the investigation. It may benefit candidates to plan their table of readings before writing the method to help them to think through the measurements that are required in order to address the subject of the investigation.

In this investigation candidates had to plan an experiment to test whether or not five 12 V heaters, all with the same power rating, were of equal efficiency. The investigation was not to find which was the most efficient.

Candidates needed to realise that a timer and a thermometer would be required.

For the method, candidates needed to measure the time taken to heat water to boiling point with one of the heaters and then to repeat this with the other heaters. A vague reference to repeating was not sufficient as it was not clear whether the heater had been changed.

The two most significant variables to keep constant are the initial temperature of the water and the volume of water.

Many candidates drew a suitable table. They were expected to include columns for the heater, and time with the units.

Candidates were expected to explain how to reach a conclusion by drawing a bar graph of the time against heater, or by comparing values from the table to see whether the heater affects the time for the water to reach boiling point. 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 understanding of practical work during the course. Candidates should have as much personal experience of carrying out experiments themselves as possible. The practical work should include reflection upon, and the discussion of the significance of results, precautions taken to improve accuracy and reliability and control of variables.

Candidates should be advised to read 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.

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

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

Many candidates were unable to derive conclusions from given experimental data and justify them.

General comments

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

The majority of candidates were well prepared and the range of practical skills being tested proved to be accessible. 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 all candidates, and there was no evidence of candidates being short of time. The majority of candidates were able to follow instructions correctly, record measurements clearly and perform calculations accurately and correctly. Units were well known and were invariably included, writing was legible and ideas were expressed logically.

Comments on specific questions

Question 1

(a) The normal to the line **LN** was almost always drawn correctly and extended downwards to cross the line **PR**. Occasionally, the point at which the normal crossed the line **PR** was not labelled with the letter **Q**, as requested in the question.

(b) The incident ray was usually drawn in the correct position at an angle of 10° to the normal, as specified. A tolerance of ± 1° was allowed here, but careless use of the protractor meant that some answers were outside this tolerance.

(c) The lengths *a* and *b* of lines **QT** and **MT** were measured within the allowed tolerance of ± 0.1 cm by the majority of candidates. Despite the instruction to measure *a* and *b* to the nearest millimetre, a few candidates recorded their answers to too few, or too many significant figures.

(d) The ratio $r = a/b$ was almost always calculated correctly, but was sometimes not recorded to 2 significant figures, as asked for in the question.

(e) The concept of direct proportion was only understood by a small percentage of the strongest candidates. Most candidates were able to look at the 3 values of θ and the three values of *r* in the table, and write down the correct statement, that *r* is directly proportional to θ. Their justification for saying this was almost always incorrect. The most common incorrect answer was that *r* is directly proportional to θ because as θ increases *r* increases. The strongest candidates gained credit here either by finding the ratio of r/θ for all 3 values of *r* and θ and showing that this gave a constant value, or by showing that doubling *r*, doubled θ and trebling *r*, trebled θ.

(f) A majority of candidates understood what needed to be done to increase confidence in the answer to **(e)**. Most realised that the investigation should be extended for additional different values of θ. A very common incorrect answer was to repeat and average using the same values of *r* and θ as before.

(g) Many candidates were able to suggest a valid source of inaccuracy in the experiment. The most common correct answers were that the ray of light has a finite thickness, so it is difficult to locate its centre, that the mirror is thick and its reflecting surface is at the back and that the experiment was not done in a dark room. Despite the fact that the experiment was concerned with the reflection of a ray of light by a plane mirror, a sizeable minority of candidates gave answers relating to the positioning of pins and parallax, which were irrelevant in the context of this question.

Question 2

(a) The reading on the voltmeter scale was almost always recorded correctly.

(b) Candidates were required to use the information supplied in **Table 2.1** to deduce the current *I* in the circuit when a 10Ω resistor was connected between points X and Y, and the voltmeter reading when a when a 47Ω resistor was connected between points X and Y. Calculations were usually correct, but once again, many candidate ignored the instruction to record the value of the current *I* to 2 significant figures.

(c) The graph axes were almost always labelled and the correct way around. 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 and more difficult for plotted points to be checked. Point-plotting was accurate, with most candidates placing their dot or cross within one-half of a small graph square of the exact location of the point.

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

(d) As expected, candidates who drew a large triangle to determine the gradient *G* of their graphs obtained the most accurate values for the gradient of the line. However, in some cases there was no clear indication on the graph of how the information to determine the gradient had been obtained, despite the instruction being given to do so.

(e) Candidates were told that the gradient *G* of their line was numerically equal to the resistance of the unknown resistor and asked to write down the value of the resistance to the nearest ohm. Candidates often ignored this instruction and did not round their value of *G* to the nearest integer.

Question 3

(a) The reading on the thermometer was recorded correctly as 87(.0) °C by the majority of candidates. Common incorrect answers were 87.5 °C, 80.7 °C and 93 °C. Some candidates misunderstood the requirement for intervals of 1 minute and interpreted the values to give readings every 5 minutes. Acceptable units for time in the table heading are min/minute(s) but not mins/m.

(b) (i) The reason for waiting for 30 s before measuring the initial temperature of the hot water was to allow the thermometer to record the highest temperature reached, or to give the thermometric liquid time to expand. Many candidates thought that it was to allow time for the temperature to become constant, which was unlikely in the context of this experiment.

(ii) Candidates misinterpreted what was required here, namely how accurate temperatures of the cooling water are obtained during the experiment. Creditworthy answers referred to perpendicular viewing of the thermometer scale, stirring the water before taking a reading, ensuring that the thermometer does not touch the sides of the beaker etc. Many responses were related to the accuracy of the final result or to improvements to the experiment. Irrelevant answers such as suggestions to repeat and average or keep the room temperature constant were common.

(c) The calculation of the average rates of cooling of the water over the first and the final two minutes of the experiment was done well. There were occasional rounding errors and answers being left as fractions.

(d) The majority of candidates succeeded in using the initial and final cooling rates of the hot water in **(c)**, to write a satisfactory conclusion which described the way in which hot water in a beaker cools. Most candidates deduced that the cooling rate of hot water decreases (with temperature/time).

(e) (i) This more demanding final part of the question proved to be challenging for many candidates. Candidates were asked to estimate the temperature of the water after cooling for a further 5 minutes. Having deduced in **(d)**, that the rate of cooling decreases with time, it was expected that candidates would realise that the temperature decrease in a further 5 minutes would be less than the temperature decrease in the first 5 minutes. Any value of final temperature which showed a smaller decrease in temperature of the water over the second 5 minute cooling interval was accepted here.

(ii) Candidates were more successful in predicting the temperature of the water after a further 50 minutes of cooling. A majority realised that it would have cooled down to room temperature/21.5 °C, or very close to it. A small range of temperatures either side of the quoted room temperature was accepted.

Question 4

Initial credit was available for candidates stating the one variable that they had chosen to investigate. The variable needed to be clearly stated to obtain credit, and not just implied in the method, table or analysis and left for interpretation. The most popular variable chosen was the mass of the ball. Other acceptable variables seen were diameter of ball/height of release/separation of the retort stands.

Further credit was available for stating any other apparatus, apart from the apparatus listed in the question, that they would need to do the experiment. Most candidates realised that they would also need a ruler, but many candidates omitted to state any additional apparatus they would need to measure their chosen independent variable – if not height of release or diameter of ball, where a ruler would suffice.

Credit was then awarded for giving a brief explanation of how the investigation would be carried out. Most candidates first measured the independent variable and released the ball, and then measured the height h and repeated for a new value of the independent variable.

Candidates had little trouble in suggesting a key variable to control during the experiment. Any significant control variable appropriate to the independent variable was acceptable.

Most candidates drew an acceptable table of results with clear columns with appropriate units for their chosen independent variable, and the dependent variable h.

Fewer candidates explained satisfactorily how they would use their results to reach a conclusion, because they made predictions about the outcome. An answer suggesting they should compare the results to see if/how/whether the mass/diameter/height of release of the ball affects the height *h*, was all that is required. Many stronger candidates also suggested plotting a graph of mass/diameter/height of release against *h*.

PHYSICS

Paper 0625/63
Alternative to Practical

Key messages

Candidates who were successful on this paper showed evidence of having performed a wide range of practical work in the classroom. They knew the apparatus and could describe its use in detail. They analysed data carefully and drew appropriate conclusions. They were able to write plans for experiments detailing steps logically and then followed their plans so they could reflect upon the quality of their explanations.

General comments

Candidates showed a good knowledge of the experiments included in the paper including the methods and the apparatus. They were able to take measurements, analyse data, form conclusions and critically evaluate their work. In **Question 1** it was clear that candidates had experience of performing the experiment in their own schools which led to high quality answers to many of the question parts. **In Question 2**, some candidates found following the instructions for the data analysis challenging. They would have benefitted from practicing the process of following written instructions carefully.

Candidates should ensure that they record data to the resolution of the measuring instrument, e.g. measurements with a ruler with mm markings must be recorded to the nearest mm so 15.0 cm was appropriate, and 15 cm was not appropriate.

Comments on specific questions

Question 1

(a) (i) All candidates measured three dimensions of the diagram of the modelling clay. A number of candidates made measurement errors or did not record all their measurements to the nearest mm.

(ii) Most candidates calculated the volume of their modelling clay correctly.

(b) Many answers focused on the resolution of the ruler used. The most significant source of inaccuracy was that the block of modelling clay had irregular dimensions. Those who identified this as the source of inaccuracy often suggested that the improvement was to repeat the measurements. However, they did not state the need to take these repeats in different places along the block for each dimension and then find the mean.

(c) Many responses focused on it being difficult to measure small objects or errors being more likely, without going into any further detail. The correct answer focused on the fact that when taking smaller measurements, the effect of the uncertainty in the measurement (due to the resolution of the measuring device) is greater. There is a larger percentage uncertainty in smaller measurements.

(d) (i) The vast majority of candidates read the scale correctly and stated the correct volume. A few did not interpret the scale correctly.

(ii) Many candidates referred to taking the reading at eye level or perpendicularly. A small number of candidates incorrectly referred to taking the reading at the middle/top of the meniscus. Reading from the bottom of the meniscus was already tested in **(i)** and so was not credited again.

(e) Almost all candidates gave a value for V_2 and then made the correct subtraction.

(f) Some candidates identified that the volume of the thread might affect the result or that the graduations on the measuring cylinder were large. A significant number of candidates tried to repeat the physics tested in **(d)(i)** and **(ii)**. Not reading from the bottom of the meniscus would be associated with poor experimental practice**.** Not all candidates gave a correct improvement linked to their source of inaccuracy.

Question 2

(a) Most candidates correctly placed a voltmeter between X and Y. In some cases, voltmeters were placed between the terminals of the power supply, in parallel with resistor Rp or in series with the ammeter.

(b) (i) Most candidates showed the arrow between the left side of the wire and the left side of the crocodile clip. In some cases the arrow was not drawn with care and arrow heads were not positioned correctly at each end.

(ii) Most candidates correctly read both meters. There were more errors reading the ammeter than the voltmeter.

(c) Most candidates followed the written instructions to calculate resistance. In some cases, a consistent number of significant figures was not used. There were a significant number of instances of the resistor for circuit A being truncated to 8.05 rather than being rounded to 8.06 or 8.1.

(d) (i) Most candidates followed the written instructions to state or calculate these resistances. In a small number of cases candidates copied values from their table.

(ii) Most candidates were able to state that their values were close enough or within experimental accuracy. Stronger answers showed a calculation of the percentage difference or statement relating to10% to reinforce their statement.

(e) Many answers referred to a fair test. The fixed resistor was included to limit the current in the circuit/prevent significant heating of the wire. This was recognised by a small number of candidates.

(f) Many candidates recognised that some change was necessary to the circuit. Some suggested that the current must be reduced but did not give a method for doing this. Using thinner wires or reducing the emf of the power supply were both common correct answers.

Question 3

(a) There were many references to moving the screen or the lens. However, relatively few candidates referred to moving the screen back and forth or slowly.

(b) (i) Almost all candidates recorded a value for h_I. A significant number gave an answer to the nearest cm rather than the nearest mm. Candidates needed to match the resolution of their answer to the resolution of the other measurements given in the table.

(ii) Almost all candidates calculated *D* values. Some answers were given to only 1 significant figure or were incorrectly rounded.

(c) Almost all candidates labelled axes correctly. Some scales did not begin from the origin as instructed. Points were generally well plotted. Candidates should be encouraged to plot using thin crosses rather than large circular blobs. Most lines of best fit were appropriate and had a balance of points on each side of the line. A few candidates joined the dots. Some forced their line through the origin rather than recognising and reflecting the trend in the data.

(d) (i) Most candidates correctly read the intercept from their line. Those who did not start their scale at the origin generally struggled to give the correct intercept for their line.

(ii) Most candidates showed correct working and found a suitable answer for the gradient. A small but significant number of candidates tried to calculate a gradient by referring to the number of 2 mm squares on the graph paper rather than using their axis scale.

(iii) Generally, most candidates were in range.

(e) Candidates found it challenging to identify a suitable difficulty and give an appropriate improvement.

Question 4

Marking point 1: Candidates often repeated the list of available apparatus. Some candidates identified that a measuring cylinder or balance was required. Many referred to a scale (rather than (weighting) scales) which is what is printed on, for example, a ruler. This cannot be used to measure mass. Many candidates omitted the ruler which was required to measure the diameter of the dish.

Marking point 2: The majority of candidates explained how to do the experiment well.

Marking point 3: Most candidates referred to repeating the measurements. In some responses, this was not clear as candidates referred to performing the experiment on five dishes all at the same time.

Marking point 4: Candidates were very strong on identifying control variables and most identified at least two.

Marking point 5: Candidates needed to note that this was a results table. This meant that any measurements they made should have been recorded in this table. Not all candidates drew a table or referred to column headings. Many candidates omitted the units.

Marking point 6: The most common way to score credit here was to draw a graph with the axes stated, not just suggesting ‘draw a graph of the results’. Another way was to say ‘look at the results and see if the mass evaporated changes as the diameter increases’. Some candidates gave a prediction instead of a conclusion e.g. “as the diameter increases the mass evaporated will increase” and so did not score credit here. Many successful candidates seemed to have been taught a pattern: ‘plot a graph of the dependent variable against the independent variable, see if changing the independent variable affects the dependent variable’.

Marking point 7: There were various ways of gaining credit here. The most common was to use at least five different diameters, or to state a second control variable. Some candidates made the mistake of stating ‘repeat the experiment and take the average’ when they should have written ‘repeat the readings for each length and take the average’.