PHYSICS

Paper 0625/11
Multiple Choice (Core)

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

General comments

Candidates demonstrated very good knowledge of the behaviour of gas particles when the temperature of the gas increased, and the process of melting. However, there were some misconceptions about current in a series circuit and the acceleration of a falling object.

It was evident that calculations involving echoes and energy transferred were not well understood.

Comments on specific questions

Question 3

This question assessed candidates' knowledge of acceleration due to gravity. The majority of candidates had the misconception that the acceleration of an object falling to the Earth decreases as the object falls.

Question 4

Most candidates found this question challenging. Many candidates incorrectly thought that gravitational force was equal to the weight per unit mass.**Question 8**

Most candidates struggled with this question with the majority of candidates failing to recognise that the steel sphere becomes warmer.

Question 13

The majority of candidates demonstrated very good knowledge about the behaviour of gas particles when the temperature of the gas increased.

Question 22

Although most candidates recalled that microwaves are used for satellite television, many candidates had the misconception that infrared was used for security marking, and so chose option **A**.

Question 23

The most common incorrect answer was option **D**, indicating that candidates had forgotten to halve the time given in the question. This is a typical error that candidates make when attempting questions involving echoes so candidates would benefit from practice of this type of question.

Question 27

Candidates struggled with this question where they had to use the equation relating energy, power and time. The majority of candidates did not convert the time from minutes into seconds and therefore incorrectly chose option **C**. Many weaker candidates also did not use the correct equation for energy. For numerical questions, candidates would benefit from writing down the relevant equation and their calculations to check that the units are correct, before looking at the different options.

Question 29

Only stronger candidates answered this correctly. Most candidates identified that this was a series circuit, but most candidates had the misconception that current decreases in the circuit as you go further away from the battery, and therefore chose option **C**.

Question 30

In this question, candidates had to calculate current by converting power from kW into W and rearranging the equation power = current × potential difference, and then choose an appropriate fuse size. Only stronger candidates answered this correctly. Other candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 35

Stronger candidates performed well on this question. Most weaker candidates demonstrated poor knowledge about the random nature of radioactive decay and tried to spot a pattern, resulting in option **C** being chosen.

Question 39

Most candidates demonstrated excellent knowledge about the Sun and the Milky Way.

PHYSICS

Paper 0625/12
Multiple Choice (Core)

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

General comments

Candidates demonstrated very good knowledge of how the pressure and volume of a gas changes and about bodies in the solar system. However, there were some misconceptions about evaporation.

It was evident that induced magnetism and some unit prefixes were not well understood.

Comments on specific questions

Question 1

This question required candidates to read the volumes of liquids in three different measuring cylinders. Most stronger candidates were able to read the volumes correctly, but a significant number of weaker candidates read the scale on measuring cylinder 2 incorrectly.

Question 8

Only stronger candidates performed well on this question. Many weaker candidates calculated the correct numerical answer but thought that work done was measured in watts, and so chose option **C**.

Question 10

Only stronger candidates answered this question about power correctly. Other candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 13

The majority of candidates demonstrated an excellent understanding of what happens to the pressure and volume of the air trapped inside a cylinder in this question.

Question 15

The majority of candidates found this question about evaporation very challenging. Although most candidates knew that particles escaped from the surface of the liquid during evaporation, they had the misconception that the remaining liquid heats up and therefore chose option **C**.

Question 18

Although the majority of stronger candidates correctly identified the wavefront on the diagram, a significant number of candidates across all ability levels incorrectly identified the arrow representing the direction of wave motion as the wavefront and therefore chose option **A**.

Question 21

Although most candidates appeared to recall that as either frequency or wavelength increases, the other decreases, many candidates had the misconception that the frequency at position P was greater than the frequency at position Q.

Question 24

The majority of candidates across the ability levels found this question very challenging. Most stronger candidates thought it was possible that bar PQ could be an iron bar, but that would result in the reading on the scale decreasing. Weaker candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 26

The majority of candidates did not recognise that a unit change from milliamps to amps was necessary and therefore chose option **B**. A significant number of weaker candidates were also unable to recall the correct equation for resistance and incorrectly multiplied the p.d. by the current (in milliamps). Candidates would benefit from short activities in lessons where they practice converting between different units and using unit prefixes.

Question 29

The majority of candidates across the ability levels did not look carefully enough at the diagram or did not understand that the direction of each cell must be considered when determining the total e.m.f. of a battery. The most common answer was therefore option **D**.

Question 35

The majority of stronger candidates correctly identified the type of ionising radiation being emitted by the substance. However, weaker candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 38

Candidates across the ability levels demonstrated very good knowledge of bodies in the solar system but some weaker candidates had the misconception that object Q was a star and object R was a moon.

PHYSICS

Paper 0625/13
Multiple Choice (Core)

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

PHYSICS

Paper 0625/21
Multiple Choice (Extended)

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

General comments

Candidates demonstrated very good knowledge about evaporation and changes of state. However, there were some misconceptions about the acceleration of free fall and how the Sun is powered.

All candidates struggled to compare the resistances of wires with different dimensions and weaker candidates struggled with numerical questions involving unit conversions.

Comments on specific questions

Question 1

Most stronger candidates identified the measurement that was recorded to the nearest millimetre. However, weaker candidates struggled to do this, with a significant number choosing option **D**.

Question 2

The vast majority of stronger candidates were able to calculate the distance correctly. Although most weaker candidates recalled the correct equation, many of them did not notice that they had to convert minutes into seconds and therefore chose option **A**. Candidates would benefit from short activities in lessons where they practice converting between different units and using unit prefixes.

Question 4

Candidates demonstrated a poor understanding of the acceleration of free fall of an object, with many candidates having the misconception that the acceleration of free fall increases as the object falls.

Question 7

This question required candidates to recall an equation which gave the momentum change of an object. The majority of stronger candidates were able to identify the correct equation, but most weaker candidates thought that momentum change depends on distance.

Question 11

Nearly all candidates used the correct equation relating pressure, force and area in this question. However, most weaker candidates did not read the question carefully enough and did not notice that the question asked for the area of each foot. Candidates would benefit from highlighting key words and phrases in questions to reduce the chance of them missing out important information.

Question 15

This question assessed candidates' understanding of the definition of specific heat capacity. Nearly all stronger candidates answered this correctly, but many weaker candidates thought that 1 kg of aluminium required more energy to raise its temperature by 1 °C than the same mass of copper because aluminium was a poorer conductor of thermal energy than copper.

Question 25

This question required candidates to recall the equation relating charge, current and time and convert minutes into seconds. The vast majority of stronger candidates were able to calculate the charge correctly. Although most weaker candidates recalled the correct equation, many of them again did not notice that they had to convert minutes into seconds and therefore chose option **B**.

Question 27

In this question, candidates needed to compare the resistances of wires with different lengths and different diameters. All candidates found this question extremely challenging, especially when applying the relationship between resistance and diameter. It appeared that most stronger candidates were aware that as the length doubled, the resistance doubled. However, the most common error was thinking that if the diameter was a quarter of the initial value, the resistance was 1/4 of the initial value instead of 1/16, resulting in a ratio of 1 : 8 instead of 1 : 32.

Question 28

Most stronger candidates identified the circuit symbols for a fixed resistor and a diode. Some weaker candidates confused the symbol for the fixed resistor with that of the variable resistor.

Question 31

This question required candidates to determine the direction in which a rod was moved across a magnetic field so that there was an induced current from end X to end Y. The majority of stronger candidates were able to work out in which plane the rod was moved but about the same number of candidates chose into the paper (option **C**) as out of the paper (option **D**). Weaker candidates' responses were more evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 33

Candidates found this question on transformers very difficult with most candidates choosing options **B** or **C**.

Question 39

The majority of stronger candidates recalled that the Sun is powered by fusion reactions but many weaker candidates had the misconception that the Sun is powered by fission reactions.

PHYSICS

Paper 0625/22
Multiple Choice (Extended)

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

General comments

Candidates demonstrated very good knowledge of moments about a pivot and of stored gravitational energy. However, there were some misconceptions about how energy is stored on the Earth and how the combined resistance of resistors in parallel is calculated.

It was evident that determining the direction of the force experienced by a wire and calculating corrected count rates were not well understood.

Comments on specific questions

Question 7

For this question, candidates had to recall an expression for impulse. Nearly all stronger candidates answered this correctly but many weaker candidates chose option **B**.

Question 8

Nearly all candidates recalled that energy is released in the Sun by fusion and transferred from the Sun to the Earth by radiation, but the majority of weaker candidates had the misconception that the energy is stored on the Earth as nuclear fuel instead of as biofuel.

Question 10

Most stronger candidates chose the correct option. Weaker candidates found the question more difficult and often chose option **C**.

Question 11

Candidates found this question challenging with many candidates choosing option **B**. These candidates calculated the change in pressure but did not use this value to then work out the pressure at the top of the hill.

Question 14

Candidates demonstrated excellent knowledge of changes of state.

Question 21

The majority of stronger candidates demonstrated good knowledge of how a lens can be used to produce a real, enlarged image of an object. However, weaker candidates often thought that the object should be placed at the focal point and therefore chose option **C**.

Question 22

Many candidates, especially weaker candidates, did not look carefully enough at the units in the options for the speed of electromagnetic waves in a vacuum and therefore incorrectly chose option **D**.

Question 27

This question required candidates to identify the correct current-voltage graph for a filament lamp. Most stronger candidates identified the correct graph but weaker candidates' answers were spread almost equally between options **A**, **B** and **C**, indicating some guesswork.

Question 31

Candidates of all ability levels struggled with this question which assessed candidates' ability to determine the direction of the current induced in a wire when it moved through a magnetic field, and also the direction of the force experienced by the wire. Although most candidates correctly determined the direction of the induced current, the majority did not recall that the direction of the force on the wire was opposite to the direction in which the wire moved.

Question 34

Most stronger candidates determined the correct direction of beta particles when moving between the poles of a magnet. Many weaker candidates thought that the particles would move towards the bottom of the page, even though this was the direction of the magnetic field.

Question 36

This question required candidates to work out the average corrected total counts in 5 minutes and then to use this value to calculate the average corrected count rate. The majority of candidates across the ability levels were able to work out the average corrected total counts in 5 minutes but then forgot to divide their value by 5 in order to determine the average corrected count rate. The most common answer was therefore option **D**.

PHYSICS

Paper 0625/23
Multiple Choice (Extended)

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

General comments

Candidates demonstrated very good knowledge of floating and sinking and how the pressure of a gas changes when it is compressed. However, there were some misconceptions about energy resources and uses of regions of the electromagnetic spectrum.

It was evident that the relationship between the resistance of a conductor, its length and its cross-sectional area was not well understood.

Comments on specific questions

Question 2

This question required candidates to interpret a velocity-time graph for an elevator. Weaker candidates in particular found this question challenging, with most thinking that section QR of the graph also showed the elevator on the third floor.

Question 4

Candidates across the ability levels demonstrated excellent knowledge of how the floating and sinking of different liquids that do not mix depends on their densities.

Question 8

There were some misconceptions about energy resources with the majority of candidates across the ability levels not recognising all of the resources which depend on radiation from the Sun.

Question 20

Most stronger candidates were able to use the law of reflection, and the fact that the angles in a triangle add up to 180°, to work out the angle of reflection in mirror 2. Weaker candidates struggled with this question and most chose either options **A** or **B**.

Question 22

This question assessed candidates' knowledge of the use of regions of the electromagnetic spectrum in different applications. Nearly all candidates recognised that X-rays were not used in any of the applications, so did not choose option **D**, but answers were spread over the other three options, indicating some guesswork.

Question 23

The vast majority of stronger candidates answered this correctly. Many weaker candidates made the error of not doubling the distance before calculating the time between the man making the sound and hearing the echo.

Question 25

The majority of stronger candidates knew that the direction of an electric field due to a charged sphere is defined by the direction of the force acting on a positive charge. They then applied their knowledge to determine the direction of the force acting on an electron due to the charge sphere. Most weaker candidates had the misconception that the direction of the electric field was also the direction of the force acting on the electron and therefore chose option **C**.

Question 27

Candidates across the ability levels found this question very challenging with most candidates choosing option **A** or **B** as they did not appear to consider that the length had to change if the volume stayed constant.

Question 33

Although nearly all candidates knew that a soft iron core was required for the efficiency of a transformer to be as high as possible, many weaker candidates thought that thin copper wire would make the transformer more efficient than thick copper wire.

Question 34

This question about the nature of the products of the decay of a nucleus was answered correctly by most stronger candidates. However, weaker candidates demonstrated a lack of knowledge with strong evidence of guesswork, as answers were spread across all four options almost equally.

Question 40

Stronger candidates were able to convert 100 000 light years into metres correctly. Weaker candidates did not read the question carefully enough and chose option **B**, which was the distance of just one light-year in metres. Candidates would benefit from underlining key words, phrases and numbers in questions to help them focus on important information.

PHYSICS

Paper 0625/31
Theory (Core)

Key messages

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

- In calculations, candidates must set out and explain their working correctly. If poor or no working is shown by the candidate and it leads to the correct answer, the examiner may be able to give credit due to the merit of the work. However, when a candidate gives a wrong final answer and no working is shown, it is often impossible for the examiner to give due reward for those parts that are correct.
- Greater clarity and precision when answering questions requiring a description or explanation.
- It is important that candidates read the questions carefully in order to understand exactly what is being asked.
- In order to improve their performance candidates should practise applying their knowledge to new situations by attempting questions in support materials or exam papers from previous sessions.

General comments

A high proportion of candidates were well prepared for this paper. Equations were generally well known by better and by slightly below average candidates but a significant number struggled to recall the equations for wavespeed i.e., $v = f\lambda$ and electrical energy $E = IVt$.

Often candidates had been well taught how to apply their knowledge and understanding to fairly standard situations. On occasions, when asked to apply their knowledge to a new situation, they could become confused and display a lack of breadth of understanding. More successful candidates were willing to think through the possibilities and apply their knowledge when the question asked for suggestions to explain new situations. Less successful candidates found difficulty in applying their knowledge to new situations and did not show the stages in their working and did not think through their answers before writing.

The English language ability of most of the candidates was adequate for the demands of this paper. There were a very small number of candidates, who struggled to express themselves adequately. One point was raised by a few examiners – the numeral 4. Candidates can make this look like 9, 7, 5, 3 and 1. If a candidate is doing a calculation where marks are awarded for a correct numerical answer, it is in their interest to ensure that the correct numeral is being marked.

Comments on specific questions

Question 1

(a) The majority of candidates correctly identified the speed of the cyclist as 8 m / s.

A common error was to divide 8 by 15 to give an answer of 0.533.

(b) This item was well answered by most candidates. Common errors included incorrectly writing increasing acceleration for part 1 and increasing/decreasing deceleration for part 3. However, the most common error was failing to describe region 2 correctly. Many candidates simply wrote ‘constant’ instead of ‘constant speed’.

(c) The majority of candidates derived the correct answer of distance travelled as 40 m by determining the area under the graph. A few tried using distance divided by time with the attendant risk of not using the average speed. The most common error however was to use an incorrect equation i.e., distance = speed/time to give 0.8. This did not score any marks.

Question 2

(a) The vast majority of candidates correctly gave the resultant force as 20 N to the left/forwards. Weaker candidates added the forces instead of subtracting 10 from 30. Many stated a direction on a compass i.e., East or West. Candidates must be made aware that this does not score unless the compass directions are added to the diagram by the candidate.

(b) (i) The majority of candidates correctly determined the work done as 2000 J. The most common error was to state that work done = force/distance and use this to give 0.8 J. This does not score any marks.

(ii) The majority of candidates scored one mark for either kinetic energy store or thermal energy store. Common errors included friction, chemical energy store and potential energy store.

(c) The majority of candidates correctly determined the pressure as 6.3 N / cm^2. The most common error was to use an incorrect rearrangement of the equation $P = F \div A$ such as $P = F \times A$ to give an answer of 9120 N / cm^2.

Question 3

(a) The majority of candidates gave very clear descriptions of how to use the measuring cylinder to find the volume of the piece of metal using a displacement method. Some candidates did not score full marks because their answers lacked detail or clarity.

E.g., many candidates failed to state that once the water was added to the measuring cylinder that its ‘volume’ should be read from the scale on the measuring cylinder. Similarly, after the metal was submerged.

Many candidates simply stated ‘After adding the water to the measuring cylinder take a reading.’

(b) The majority of candidates correctly determined the density of the metal as 19.4 g / cm^3. The most common error was to use an incorrect arrangement of the equation $D = M \div V$, usually $D = M \times V$ to give an answer of 6300.

Question 4

(a) (i) The vast majority of candidates correctly determined the wasted output energy as 12 J.

(ii) Most candidates correctly identified the energy store as the thermal energy store.

(b) Candidates found this item surprisingly difficult. Only more able candidates scored full marks for an answer of 4500 J. The most common error was failing to convert the time to seconds. These candidates usually scored 3 marks for an answer of 75.

Many candidates could not recall the equation electrical work done = power x time Centres are advised that candidates should practise writing out all the equations on the syllabus to assist with recall.

(c) Candidates found this item surprisingly difficult. Centres are advised that candidates should practise using flow diagrams to represent the energy transfers involved in common devices and in electricity generating systems.

Question 5

(a) The majority of candidates scored well on this item. This is a part of the syllabus that is obviously well understood. Vague answers such as ‘fixed shape/no fixed shape’; ‘move in any direction/freely’; ‘not too far from each other’ or ‘loosely packed’ were the usual reason for marks to be withheld. A common error was to describe particles in a solid rather than in a gas.

(b) Many candidates scored marks for descriptions including: ‘speed decreases’ ‘(because) kinetic energy **or** (internal) energy decreases’ ‘(and so) collision rate decreases.’ Common errors included stating that the particles will stop moving or that the speed increases as the temperature decreases.

Question 6

(a) Most candidates were able to state that the second sound was caused by the sound waves reflecting off the rocky cliff face to give an echo.

(b) The majority of candidates scored full marks by determining the distance as 440 m. Common errors included: halving the distance as they mistakenly treated the sound from the fireworks as an echo and much more common was an incorrect rearrangement of the equation speed = distance ÷ time. Many candidates used distance = speed ÷ time.

Question 7

(a) (i) (ii)(iii) The majority of candidates identified the correct process for one or two effects but only the more able correctly identified all three. Centres should ensure that candidates have seen diagrams of these effects in ripple tanks.

(iv) Most candidates struggled with this item. Only the more able candidates stated that the change in direction was due to a change in the speed of the wavefronts as they moved from deep water to shallow water.

(b) Most candidates struggled with this item. Only more able candidates seemed able to give a precise description of the direction of vibration of the particles in a transverse wave. The most common error was in failing to link the vibrations as being perpendicular to the direction of propagation of the wave. Vague references about the direction of the wave were insufficient.

(c) Candidates found this item surprisingly difficult. Only a minority correctly identified radio waves and light waves as examples of transverse waves.

(d) The majority of candidates successfully calculated the wavelength as 6.0 m. The most common error was to give an incorrect rearrangement of the equation for wavespeed, i.e., $v = f \times \lambda$. The most common of these was $\lambda = v \times f$

Question 8

(a) (i)(ii) Candidates found these items surprisingly difficult with only a minority giving the image distance as 0.11 m and even fewer identified the focal length as 0.08 m.

(iii) Candidates found this item surprisingly difficult. Only a minority gave the properties of the image in Fig. 8.1 as (any two from;) real, inverted or diminished.

(b) (i) Many candidates did not recognise the electromagnetic spectrum in order of increasing wavelength and consequently gave microwaves and radio waves instead of X-rays and gamma rays. Centres should ensure that candidates are familiar with the electromagnetic spectrum in order of increasing frequency and increasing wavelength.

(ii) The vast majority of candidates were able to give a use for ultraviolet radiation.

(iii) The vast majority of candidates were able to give one danger of excessive exposure to ultraviolet radiation.

Question 9

(a) Most candidates gave a correct description such as: close the switch and then see if the lamp lights **or** there is a reading on ammeter. The most common error was to omit the detail from the description i.e., 'see if there is a current in the circuit' 'look at the lamp' did not score the second mark.

(b) This is a difficult concept and only the more able candidates scored full marks. Common errors were omitting to mention 'free electrons' and the idea that an e.m.f. was needed to move the free electrons around a circuit.

Question 10

(a) Many candidates could not recall the equation $E = I \times t \times V$, with many using $E = (V \times t) \div I$, possibly from a mistaken idea linked to resistance.

(b) A surprising number of candidates could not recall the three wires in a mains cable as earth, live and neutral. Most candidates could name one or two. Weaker candidates tended to give the names of three metals.

(c) The transformer calculation was very well done by many candidates.

The most common error was an incorrect equation as the starting point.

A number who did start with the correct equation made errors in rearranging the equation.

Question 11

(a) The vast majority of candidates correctly identified the four planets. A common error was to interchange Mercury and Mars or to interchange Jupiter and Saturn.

(b) This item proved to be a good discriminator with more successful candidates giving clear and detailed descriptions. Less successful candidates often gave some detail about the Big Bang or the formation of a star.

PHYSICS

Paper 0625/32
Theory (Core)

Key messages

Candidates should note both the number of marks available and the space allocated for responses, as these factors provide a clear indication of the type 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 answer is incorrect. Candidates who wish to change their final numerical answer should cross out the incorrect version and write the correct value clearly. Simply overwriting is usually ambiguous and could mean that credit cannot be awarded.

Candidates should be reminded about significant figures and rounding their final answer. Quantities are usually given to two significant figures and the number for the answer should be rounded and also given to two significant figures (see comments for **Questions 2(c)** and **7(c)**). The only exception is if the answer is a whole single figure number, e.g. 10 ÷ 2 = 5.

General comments

Some areas of the syllabus were better known than others. In particular, areas which were not as well understood included energy resources and energy stores, the relationship between the motion of particles and temperature, the transfer of thermal energy (particularly convection and radiation), explaining the charging of solids by friction, radioactivity and aspects of the Universe.

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

For many candidates, the non-numerical questions were more challenging than the numerical questions. 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 failed to state how it had changed i.e. whether it had increased or decreased.

Comments on specific questions

Question 1

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

(b) Many correct answers were seen. A common error was giving the total time shown on the distance–time graph.

(c) Most candidates gained credit for recalling the speed = distance ÷ time equation. A smaller number of candidates achieved full credit. Other candidates either used an incorrect time from the graph or did not recognise that the correct time of 20 minutes needed converting to seconds.

Question 2

(a) Many candidates realised that measuring the width of all 12 loops and then dividing by 12, was an accurate way to determine the diameter of the wire. Full answers explained, or showed on the diagram, how to use the ruler to measure the 12 loops.

(b)(i) (ii) The majority of candidates gave the correct answers. However, a common error for **(ii)** was misreading the volume reading when the wire was in the water. A value of 30 cm^3 was common. Candidates usually showed their working and could be awarded credit for the method.

(c) Again, a large number of candidates gained full credit with most showing both the correct equation and full working. However, some candidates calculated a value for the density of 8.888…, but then gave a final incorrect answer of 8.8 g/cm^3 instead of the correct answer of 8.9 g/cm^3.

Question 3

(a) (i) Most candidates answered this question well and showed both the correct equation and full working.

(ii) A significant number of candidates appeared to have misread the question and their answer was to increase the force. Apart from this error, many versions of the correct answer were seen.

(b) Many candidates gained at least partial credit with most showing both the correct equation and full working. Stronger candidates were able to give the correct units for full credit. A number of candidates did not give a response.

Question 4

(a) (i) (ii) Most candidates were aware of an example of a renewable energy source. However, the meaning was often described incorrectly as an energy that can be reused or used many times. Examples of correct answers were an energy source that was replenished or did not run out.

(b) (i) (ii) The majority of candidates gave the correct answers.

(c) Answers were often too vague and needed further development e.g. "dependant on the weather" or "needs a suitable location". More comprehensive ideas, such as being dependant on rainfall or needing deep valleys/high hills were required.

Question 5

(a) Candidates would generally benefit from more experience converting degrees Celsius to and from kelvin. A number of candidates did not answer this question.

(b) Candidates needed a fuller understanding of how to explain changes in the pressure of a gas in terms of the motion of its particles and their collisions with a surface. Many candidates knew that the pressure would decrease but a smaller number linked this to the particles having less kinetic energy or moving more slowly and very few developed their explanation further. Consequently most answers only matched two of the four marking points available. A noticeable number of candidates suggested that the pressure would increase because the gas was trapped inside the bottle or gave no response.

Question 6

(a) Candidates needed a fuller understanding of how density changes explain the formation of convection currents in gases. A number of candidates gained partial credit for knowing that the hot air would rise.

(b) Again, candidates generally lacked sufficient understanding of the transfer of thermal energy by radiation. Explanations often showed confusion between emission, absorption and reflection of infrared radiation.

(i) Many incorrect answers were based on ideas about conduction and insulation.

(ii) Some candidates understood that the shiny foil would reflect something, but this was often incorrectly identified as heat particles.

Question 7

(a) Confusion between transverse and longitudinal waves was evident here.

(b)(i) Many candidates were able to recall the use of a ripple tank to show diffraction due to a gap. Most were able to draw diffracted wavefronts with a constant wavelength, but others found this skill more challenging.

(ii) Only stronger candidates recognised that the wavelength was the distance between two successive wavefronts. A common error was to identify a wavefront as being a wavelength. A number of candidates did not give an answer to this question.

(c) Many candidates scored full credit for an answer of 8.3 Hz and showed both the correct equation and full working. Two common errors were using an incorrect rearrangement of $V = f \times \lambda$, or attempting to use speed = distance/time, with frequency substituted for the time. In addition, some candidates calculated a value for the frequency of 8.2609 but gave a final incorrect answer of 8.2 Hz instead of the correct answer of 8. 3 Hz.

Question 8

(a) The majority of candidates knew that the process was charging by friction. However, there was a common misconception that electrons (negative charges) moved on to the cloth and protons (positive charges) moved on to the acetate. Stronger candidates realised that it is just the electrons that are transferred.

(b) The majority of candidates scored full credit here.

Question 9

(a) This question was answered well by many candidates. Other candidates gave answers that were too vague e.g. "use a bigger magnet" rather than a stronger/more powerful magnet or "use a bigger coil" rather than increasing the number of turns on the coil.

(b) This question was answered well by many candidates, with many scoring full credit for evaluating the number of secondary turns to be 440. Weaker candidates gained partial credit for recalling the transformer equation correctly. Rearranging this equation proved too difficult for many candidates. A number of candidates did not give a response.

(c) Few candidates fully understood how a fuse protects a circuit. Answers tended to be too vague using such phrases as 'when something wrong happens', 'electrical overflow', 'too much electricity' etc. Also, a common incorrect answer was that a fuse 'controls' the current rather than the idea that the fuse melts when the current exceeds a certain value/limit. The statement that a fuse is connected to the live wire, although correct, did not answer the question. A number of candidates did not give a response.

Question 10

There were a large number of blank responses for this question (apart from **(b) (ii)**).

(a) (i) Most candidates scored full credit here.

(ii) Most candidates identified alpha-particles (α-particles) as being the type of nuclear emission. A common error was beta (β).

(iii) The vast majority answers were correct.

(b) (i) A number of candidates gained partial credit for recognising that time period was equivalent to 3 half-lives. Few were able to take the calculation further.

(ii) This item was answered well by many candidates. The most common error was confusing the electron and neutron numbers.

Question 11

(a) (i) (ii) The vast majority of candidates scored full credit here.

(iii) Most candidates were able to name the Milky Way. A significant number also realised that gravity provided the pulling force. Only a few candidates displayed knowledge of the accretion model.

(b) (i) Very few answers were incorrect here.

(ii) Many correct answers were seen. A common incorrect response was one day.

(iii) Many correct answers were seen. A common incorrect response was one km.

PHYSICS

Paper 0625/33
Theory (Core)

Key messages

Candidates should note both the number of marks available, and the space allocated for responses, as these factors provide a clear indication of the type 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 (see comments on **Questions 7 (b) (iv)** and **8 (a) (i)** and **(ii)**).

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. Simply overwriting is usually ambiguous and could mean that credit cannot be awarded.

General comments

Some areas of the syllabus were better known than others. In particular, areas which were not as well understood included energy stores, certain aspects of the general properties of waves (see comments on **Question 6 (a)** and **(b)**), the uses of microwaves, the application of the electrical power equation, radioactive emission and the Universe.

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

For many candidates, the non-numerical questions were more challenging than the numerical questions. 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 failed to 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 answered this correctly. Other answers were too vague, e.g. ‘constant motion’ rather than ‘constant speed’.

(ii) A large number of candidates answered this question well with most showing full working. Weaker candidates often attempted to use an incorrect equation, i.e. distance = speed ÷ time.

(b) (i) The vast majority of candidates answered this correctly.

(ii) A significant number of candidates gained full credit here by showing full working and giving the correct unit. The most common errors were, having recalled the correct equation, substituting the distance from **(a) (ii)** and/or an incorrect time.

(c) (i) Many candidates answered this well. A clear direction needed to be indicated e. g. backwards or forwards or to the left or to the right. The answer 'East' or 'West' etc. required the points of the compass to be shown as well.

(ii) Candidates needed to know that a resultant force may change the speed of an object. In this case increasing in the speed of the cyclist. A common error was to name the resultant force as frictional force.

Question 2

(a) Many candidates realised that measuring the length of all 11 coils, and then dividing by 11, was an accurate way to determine the diameter of the wire. Fuller answers included the use of a ruler to measure the length of the coils. A number of candidates did not give an answer.

(b) (i) The vast majority of candidates answered this correctly.

(ii) Many correct answers were seen. A common error was adding the extension to the load.

Question 3

(a) A large number of candidates gained full credit with most showing both the correct equation and full working. Rearranging the equation was more challenging for other candidates. Candidates should be reminded to 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/s^2)'.

(b) Many candidates gained full credit and showed both the correct equation and full working. There were a number of incorrect equations, usually pressure = force × area.

Question 4

(a) Candidates generally lacked knowledge of the principle of the conservation of energy. Many incorrect answers merely stated "an energy store". A number of candidates did not give an answer.

(b) (i) Electrical energy was a very common incorrect answer.

(ii) Kinetic energy, the correct answer, was seen frequently. Potential energy was the most common incorrect answer.

(ii) The majority of candidates answered this correctly.

Question 5

(a) (i) Most candidates achieved partial credit here but knowledge of the lowest possible temperature of matter was less secure.

(ii) Candidates would benefit from more experience converting degrees Celsius to and from kelvin. Many candidates did not give an answer to this question.

(b) (i) (ii) Most candidates were familiar with this experiment to demonstrate thermal conduction and gave complete answers.

(c) The majority of candidates correctly identified the black squares. Explanations often showed confusion between emission, absorption and reflection of infrared radiation.

Question 6

(a) Confusion between transverse and longitudinal waves was seen here, and a high number of candidates gave no response.

(b) (i) (ii) Few candidates knew that refraction is the term for the change in direction of a wave and that refraction is due to a change of speed.

(iii) Many candidates scored full credit for an answer of 6.7 Hz and showed both the correct equation and full working. The most common errors were using an incorrect rearrangement of $V = f \times \lambda$ or attempting to use speed = distance ÷ time, with frequency substituted for the time.

Question 7

(a) Many candidates gained at least partial credit here. Knowledge that infrared is a suitable type of electromagnetic wave for using in electric grills was less secure. A common error was stating that X-rays, instead of ultraviolet, were typically used to detect fake bank notes.

(b) (i) (ii) Candidates generally lacked the knowledge that communication with artificial geostationary satellites for satellite television is mainly by microwaves. Many candidates did not give an answer to this question.

(iii) Many candidates realised that the Sun is the source of the energy that powers the solar cells, but other candidates gave no response.

(iv) A significant number of candidates appeared to have misread the question. The question asked how energy is transferred from the solar cells not to the solar cells. Consequently light, sunlight, and ultraviolet were incorrect answers. A number of candidates did not give an answer to this question.

Question 8

(a) (i) (ii) Many candidates answered this question well. Others appeared to have misread the question. These two questions asked for 'which switches' (plural). Many candidates only gave one switch for each question.

(b) The majority of candidates correctly calculated the resistance of the lamp to be $11\,\Omega$, with most candidates showing both the correct equation and full working. A common error was using an incorrectly rearranged form of the equation $V = I \times R$. The most common of these was $R = V \times I$.

(c) Many candidates did not recall the equation for power transferred: $P = I \times V$. Stronger candidates showed a good understanding of units. A number of candidates did not give an answer to this question.

Question 9

(a) Only stronger candidates demonstrated the knowledge that a changing magnetic field linking with a conductor can induce an e.m.f. in the conductor.

(b) This question was answered well by many candidates with most scoring full credit for evaluating the number of turns on the secondary coil to be 270. Weaker candidates gained partial credit for recalling the transformer equation correctly. Rearranging this equation was challenging for many candidates. A number of candidates did not give an answer to this question.

Question 10

A number of candidates did not give answers to any part of this question.

(a) (i) Some candidates knew that atoms may form positive ions by losing electrons.

(ii) Very few candidates identified alpha-particles (α-particles) as the most ionising type of nuclear emission. A common error was gamma (γ) rays.

(b) Candidates generally lacked knowledge of isotopes.

(c) This question was answered well by many candidates. Weaker candidates tended to half the initial count rate giving the incorrect answer of 150s.

(d) Many candidates knew that radioactive materials should be stored in a lead container.

Question 11

(a) (i) A high number of correct answers were seen. However, a number of candidates did not give an answer to this question.

(ii) There was much confusion between the time taken by the Moon to complete one orbit of the Earth and the time taken for the Earth to rotate once on its axis.

(iii) Many candidates answered this question well and showed both the correct equation and full working. Weaker candidates often made a power of ten error in the calculation or the rearranging of the speed =distance ÷ time equation proved too difficult.

(b) Answers were generally vague and there were a noticeable number of candidates who did not give any answer here. A few candidates realised that the quote referred to the redshift of light and supported the idea of an expanding Universe.

PHYSICS

Paper 0625/41
Theory (Extended)

Key messages

Candidates should be reminded to:

- read each question carefully and answer the question that is being asked
- show their working clearly in calculations
- write formulae using the symbols for variables stated in the syllabus
- describe and explain phenomena with clear statements.

Final answer marks for calculations are only awarded for correct numerical answers with the correct unit. Where either the numerical value is incorrect or the unit is missing or incorrect, marks are only awarded for working shown.

General comments

Candidates generally demonstrated good quantitative skills in performing calculations. Some candidates found working with numbers in standard form was challenging, as seen in **Question 9**.

Many candidates demonstrated a good understanding across the range of topics within the physics syllabus including continued improvement in the new topic of space physics. Candidates had some difficulty in answering parts of **Question 6** suggesting a weakness in understanding of potential dividers.

Candidates are expected to give numerical answers to two significant figures unless instructed otherwise. Evidence of answers being rounded to one significant figure was seen in **Question 1(c)(i)**.

The syllabus specifies acceptable units for different quantities. Candidates should ensure that they give the correct unit with any numerical value. Missing or incorrect units were noticeable in **Question 1(b)**, **Question 1(c)(i)**, **Question 5(b)** and **Question 9(b)**. In **Question 2(a)(iii)** acceleration was often given the incorrect unit N/kg.

Comments on specific questions

Question 1

(a) (i) Most candidates correctly recorded both readings on the meter ruler and included the unit. Common errors included misreading the scale on the *y*-axis as 42.5 cm and 62.5 cm or omitting the unit in the answer.

(ii) Many candidates correctly calculated the extension of the spring from their values in **(i)**. Some weaker candidates incorrectly tried to use the formula $k = F \div x$.

(b) Most candidates correctly recalled the formula $k = F \div x$ and many went on to calculate the spring constant correctly. Weaker candidates made errors when rearranging the formula and some candidates omitted the unit or gave an incorrect unit with their answer.

(c) (i) Candidates recalled the formula $W = m \times g$ and used it correctly to calculate the weight of the object. Some candidates rounded their answer to one significant figure. Weaker candidates sometimes gave an incorrect unit, confusing weight with mass.

(ii) The strongest candidates calculated the resultant force correctly and gained full credit by using it to calculate acceleration. Weaker candidates were able to recall and use $F = m \times a$ to calculate an acceleration. They were more likely to use either the tension in the spring or the weight as the force rather than determining the resultant force. Some candidates incorrectly gave the unit of acceleration as m / s and, a few gave the unit as N / kg.

Question 2

(a) (i) Many candidates recorded the correct value for maximum momentum, together with a correct unit and gained full credit. Partial credit was awarded to candidates who recalled $p = m \times v$. Weaker candidates attempted to calculate a change in momentum rather than the maximum momentum. Some candidates omitted the unit in their answer.

(ii) Most candidates knew that the area under the line graph in **Fig. 2.2** represented the distance travelled by the car. A common error was to say that distance equalled the gradient of the line. Some weaker candidates gave a vague statement such as the distance travelled was the shape of the graph.

(iii) Many candidates correctly calculated the distance travelled by the car in the first 6.5 s by calculating the area of the triangle in **Fig. 2.2**. Weaker candidates used $v = s \div t$ without realising that they needed to work out the average velocity over time. Some candidates gave an incorrect unit or omitted the unit in their answer.

(b) (i) Most candidates stated either that **Fig. 2.2** showed speed decreasing or that there was a negative gradient. Vague answers, such as that the slope decreases, did not gain credit. Weaker candidates sometimes confused the feature here with the feature required in **(b)(ii)**.

(ii) Stating that the line was curved or that it was not straight were the most common ways of gaining credit here. Stronger candidates sometimes gave the more precise answer that the gradient was decreasing. Stating more generally that the gradient was changing was sufficient to gain credit but the incorrect statement that the gradient increased was not given credit.

(c) Stronger candidates gave a clear statement that energy was transferred from the kinetic store to the thermal (or internal) store. Common errors included stating that the transfer was to the gravitational potential store, introducing an intermediate store or stating that energy was transferred from some other initial store into the kinetic store.

Question 3

(a) Only the strongest candidates gained full credit for stating that the moment of a force is the force × the perpendicular distance of the force from the pivot, and that the moment is a measure of the turning effect of a force. A common error was the omission of reference to the perpendicular distance. Weaker candidates sometimes described balancing of anticlockwise and clockwise moments which is not the same as defining the moment.

(b) (i) Stronger candidates stated clearly that the centre of gravity is the point where all the weight of an object appears to act. A common error was suggesting it was a region, or area, or just stating that it was where the weight appears to act. Weaker candidates referred to gravity acting, rather than the force due to gravity or weight. Candidates who qualified their answer by stating that it is the point where most of the weight acts did not gain credit.

(ii) Only the strongest candidates gained full credit here for a correct calculation of the moment with the correct unit. Many candidates did not realise that the perpendicular distance was found by halving the distance given in **Fig. 3.1**. Some candidates gave an incorrect unit or omitted the unit in their answer.

(c) Candidates who made clear statements that the resultant force was zero and the resultant moment was zero were most likely to gain full credit. Some candidates stated that the sum of anticlockwise moments equals the sum of clockwise moments which gained credit. Many candidates gave the answer that the upward force will be equal to the downward force, which could not be credited. Some weaker candidates referred to momentum instead of moments in their answer.

Question 4

(a) Most candidates gained at least partial credit by correctly suggesting the necessary measurements required to calculate specific heat capacity or by stating the equation $c = \Delta E / (m \times \Delta\theta)$. Where other variables were given in an equation and not defined, credit was not given. For full credit, candidates needed to describe a method for transferring a measurable amount of energy and for stating how to calculate ΔE. Only the strongest candidates used clear diagrams or described the use of an electric heater and thermometer inserted into an aluminium block. Full credit then required recall of $E = P \times t$ to calculate the energy transferred to the aluminium block. Weaker candidates often used gas burners to transfer energy to the block. Credit was available for candidates who poured hot water into an insulated calorimeter with appropriate calculations, but no credit was available for using an uninsulated aluminium dish such as that shown in **Fig. 4.1**.

(b) (i) Many candidates gained partial credit by correctly stating that thermal energy was transferred from the water to the dish by conduction. Full credit required either completion of the explanation by saying that net transfer of energy stopped once the temperatures became equal or an explanation that after a short time the temperatures equalise at a value between the initial temperature of the water and the initial temperature of the dish.

(ii) Most candidates gained partial credit for stating that aluminium particles gained energy in the kinetic store. Stronger candidates gained full credit for adding that this led to increased separation of the particles. Weaker candidates often described particles expanding instead of particle separation increasing or tried to give an explanation in terms of gas pressure by referring to more frequent collisions.

(iii) Stronger candidates were able to clearly state that evaporation is the escape of the most energetic molecules at the surface of the water. Common errors included neglecting to specify the escape is from the surface or stating that there is a change of state from liquid to gas, rather than describing the escape of molecules from the liquid.

Question 5

(a) Only the strongest candidates recognised that the distance from the centre of a compression to the centre of the neighbouring rarefaction is half a wavelength. Weaker candidates tried to use $v = f\lambda$ or simply repeated the distance given in the question.

(b) Some candidates correctly recalled a value for the speed of sound in the range 330 – 350 m/s. Many gave the incorrect answer that is the speed of electromagnetic radiation in a vacuum and a few answers consistent with the speed of sound in a liquid were also seen. A few candidates omitted the unit in their answer.

(c) (i) Most candidates recalled and used $v = f \times \lambda$ to calculate the frequency of the sound using their answers to **(a)** and **(b)** and included the unit. Partial credit was given for recall of the formula even if candidates were unable to complete a calculation.

(ii) Many candidates compared their answer to **(i)** with the normal range of human hearing to explain whether the sound from the loudspeaker could be heard. Weaker candidates made no statement about whether the sound could be heard or not, or gave an incorrect range for normal hearing, or omitted any explanation.

(d) This question required a reference to diffraction for any credit. The strongest candidates gained full credit by stating that there was only a little diffraction since the gap width was much larger than the wavelength and that this explained why sound was heard at K but not at J. Some candidates contradicted a correct reference to diffraction with an incorrect reference to refraction taking place.

Question 6

(a) Only the strongest candidates gave a precise definition of potential difference (p.d.) as the work done by a unit charge passing through a component. Some candidates confused the definition with the definition of electromotive force. Weaker candidates often simply stated that potential difference is a voltage or omitted a reference to unit charge. Some candidates gained partial credit for answers that referenced the work done in moving charge.

(b) The strongest candidates, who understood the relationship between electromotive force and the potential difference (p.d.) across components in a series circuit, gained credit for stating that the p.d. across the thermistor = e.m.f – the reading on the voltmeter. Weaker candidates suggested the use of $V = I \times R$ which was not relevant here or suggested connecting the voltmeter across the LDR which did not answer the question.

(c) (i) To gain credit here, candidates needed to know that the resistance of an LDR decreases when light intensity increases, and that the resistance of a thermistor increases when temperature decreases. The correct combination of changes was seen as often as a range of incorrect responses from candidates of all abilities.

(ii) In this question candidates needed to apply their knowledge of how e.m.f. is shared across components in a series circuit in proportion to their resistance. Some candidates correctly stated that the reading on the voltmeter decreases. Only the strongest candidates were able to explain this in terms of the ratio of resistances and the ratio of voltages across the LDR and thermistor. Weaker candidates often simply stated that voltage is proportional to resistance or stated $V = I \times R$.

Question 7

(a) Most candidates correctly identified iron as a suitable material for the bar, with many giving the more precise answer of soft iron. The most common incorrect response was steel and other incorrect responses included copper or just the general term ‘metal’.

(b) (i) Many candidates drew good diagrams showing the magnetic field around the bar. They included at least one complete loop from north to south pole above and below the bar. Additional loops and/or field lines emerging from north or entering south pole were shown. Common errors included arrows going from south to north or patterns which were unbalanced with many more field lines on one side of the bar than the other. Candidates are advised to take special care when adding arrows to diagrams as sometimes correct arrows were contradicted with incorrect arrows.

(ii) The strongest candidates stated clearly that when resistance increases the current in the solenoid decreases. They then linked this to a reduction in field strength and either a greater space between field lines or a decrease in the number of lines (in same space). Weaker candidates often made unclear statements about the magnetic field decreasing which did not gain credit. Some candidates did not state clearly how the current changed. This was necessary to explain the changes in the magnetic field strength and pattern.

(c) Some candidates recognised that altering resistance of the variable resistor would alter the current in the solenoid. Few candidates linked this to the production of a changing magnetic field which was cut by the square coil. Many answers lacked clarity in expression, and it was often difficult to work out whether candidates were talking about the current in the solenoid or a current in the square coil. Partial credit was most often gained for recognising that a current or e.m.f. was being induced in the square coil. There were many misunderstandings with this question with some candidates thinking that the square coil was connected to the solenoid circuit and others thinking that the square coil rotated, i.e. an application of the motor effect.

Question 8

(a) Most candidates drew clear diagrams, using the symbols in the key, showing 6 protons and 8 neutrons in a central nucleus and 6 electrons orbiting around that nucleus and so gained full credit. Weaker candidates who mixed up the number of electrons or neutrons still usually showed the arrangement of particles correctly. Candidates should be advised to use all the space provided for a diagram and to clearly distinguish between solid, black circles and open circles as answers where the protons and neutrons were indistinct were not given credit.

(b) Full credit was gained here for a precise answer stating that an atom of carbon-14 had one more neutron and one less proton than an atom of nitrogen-14. Partial credit was given to candidates who stated carbon-14 has more neutrons and fewer protons than nitrogen-14. Credit was not given to candidates who just stated that carbon-14 and nitrogen-14 contained different numbers of protons and neutrons. When candidates are asked to describe the difference in composition, they should always try to quantify any difference.

(c) (i) Most candidates correct recalled that an electron is identical to a beta-particle. Common incorrect responses included alpha-particle, hydrogen and gamma.

(ii) Only the strongest candidates described a neutron changing into a proton as a beta-particle is emitted from carbon-14. Credit was also given for stating that one neutron was lost, and one proton was gained. Weaker candidates often only gave one half of this alternative answer or simply repeated a comparison of the two atoms already covered in **(b)**.

(d) Many candidates gained at least partial credit here for working out that 1.2×10^{11} is $9.6 \times 10^{11} \div 2^3$. For full credit, candidates needed to realise that this meant 3 half-lives had elapsed and then to calculate 3 × 5700 years. Common errors included multiplying 5700 × 8 or subtracting the final number of C-14 atoms from the original number of C-14 atoms.

Question 9

(a) Most candidates correctly stated the key point that a galaxy is made up of a (large) number of stars. Some candidates added extra detail beyond that which is required of the syllabus. Weaker candidates often confused a galaxy with the Universe. Unclear answers such as that a galaxy is made up of many solar systems did not gain credit.

(b) Stronger candidates correctly recalled 1 light-year = 9.5×10^{15} m and used this to convert the diameter of the Milky Way. Some candidates who could not recall this value tried to work it out from first principles with varying success. Other candidates made errors in the conversion of m to km resulting in a power-of-ten error in their final answer.

(c) (i) Many candidates stated that the amount of redshift or the increase in wavelength allowed the speed at which a galaxy is moving away to be determined. A common insufficient answer was mention of the wavelength without stating that it is the change in wavelength that needed to be noted. Other incorrect answers included the distance from Earth, velocity, the Hubble constant and the speed of light.

(ii) The brightness of a supernova is one different observation that is used to determine the distance to a far galaxy. Candidates who did not gain credit in **(i)** were given credit here if they suggested amount of redshift or increase in wavelength. A common incorrect response here was CMBR.

(iii) Many candidates described the relationship as the further away the galaxies are from Earth, the faster they are moving away. Stronger candidates expressed the relationship as speed being directly proportional to distance from Earth or by stating the two quantities are related by Hubble's Law. An answer that simply stated Hubble constant was insufficient to gain credit. Weaker candidates sometimes described the relationship as inversely proportional or stated that the further away a galaxy is, the slower its speed.

(iv) Most candidates recalled that the age of the Universe = $1 / H_0$ with many using this to calculate the correct value in seconds. Some incorrect answers demonstrated weakness in working with numbers in standard form. Stating the approximate age of the Universe in years did not gain credit, since the question asked candidates to use the Hubble constant provided and the unit was included on the answer line.

PHYSICS

Paper 0625/42
Theory (Extended) 42

Key messages

Candidates should be reminded to:

- read questions carefully
- set out calculations carefully and logically, showing all their working
- use the symbols for physical quantities as stated in the syllabus
- include the correct unit, and the required number of significant figures
- give logical step-by-step explanations
- make use of all information given in a question
- use a ruler and sharp pencil when drawing straight lines
- ensure that their handwriting, including their writing of numbers, is legible.

Final answer marks for calculations are only awarded for correct numerical answers with the correct unit. Where either the numerical value is incorrect or the unit is missing or incorrect, credit will only be awarded for working shown by candidates.

General comments

Overall, candidates showed that they had a good understanding across the syllabus.

Candidates showed a good understanding of equations and their use in calculations. To gain full credit in a 'show that' question, candidates should be advised to quote the full equation, including the subject, before rearranging and substituting numbers. This applied in **Question 3(b)(i)**.

The concept of impulse was misunderstood by weaker candidates in **Question 2**.

Answers to **Question 5** indicated that thermal energy transfers and the absorption of infrared radiation were less well understood than many other parts of the syllabus.

There was some weakness of understanding of electromagnetism evident in answers to **Question 9**.

Many candidates did not have a complete understanding of ratios and half-life and its application in **Questions 10(b)** and **10(c)**.

Answers should be given to two significant figures, unless a different number of significant figures is asked for in a question. Rounding to only one significant figure was often seen in **Question 8(b)**.

Comments on specific questions

Question 1

(a) (i) Many candidates gave the correct numerical answer with the correct unit. Weaker candidates omitted the unit or gave an incorrect unit, and the weakest candidates divided the mass by *g*.

(ii) This question asked for a definition of weight. Stronger candidates correctly referred to the gravitational force acting on a mass or an object. Weaker candidates just stated $W = m \times g$ or only referred to a force instead of a gravitational force.

(b) (i) Most candidates recognised that the motion was acceleration. Stronger candidates correctly referred to increasing acceleration and constant acceleration respectively. Some weaker candidates made no reference to increasing acceleration and the weakest answers referred to a decrease in speed.

(ii) Most candidates were able to draw a tangent at the correct point. Many correctly calculated the value of the acceleration and stated the correct unit. Weaker candidates either omitted the unit or gave an incorrect unit or just divided the value of the speed at t = 400 s by the time.

(c) Many candidates correctly stated that terminal velocity occurred when air resistance balanced the gravitational force or when the resultant force was zero. Stronger candidates identified that this was because the air resistance increased as the velocity increased. Common errors included references to a force being balanced by an acceleration or extra forces on the rocket. The weakest candidates gave irrelevant answers about energy changes or effects on the satellite.

Question 2

(a) The majority of candidates gave the correct definition of momentum. Common errors were confusion between moments and momentum with answers defining a moment, or vague references to mass and velocity or the use of speed not velocity.

(b) (i) Stronger candidates correctly identified that the equation required was impulse = $\Delta(m \times v)$ and gave a correct unit for their answer. Weaker candidates attempted to use $F = \Delta(m \times v) / t$ or used the value for time in their calculations.

(ii) Most candidates gained full credit. The strongest candidates recognised that they could use their answer to **(i)** and divide it by time to calculate the force. Many candidates whose understanding of impulse was limited used the longer method of calculating the force using $F = m \times a$ and $a = \Delta v / t$. Most candidates stated the unit correctly.

Question 3

(a) Most candidates correctly identified at least one suitable energy source, and the majority correctly named two. The most common answers were wind and solar. Weaker candidates gave sources that were not dependent on the Sun or vague answers, e.g. thermal energy or light energy.

(b) (i) Most candidates gained full credit for this question. They stated the full equation $E_K = ½ \text{ m} \times \text{v}^2$ in words or symbols. They followed this with either a rearrangement making m the subject of the equation or gave evidence of correct working with a numerical answer to 3 or more significant figures. Weaker candidates sometimes only wrote part of the equation such as $½ \text{ m} \times \text{v}^2$ which did not gain credit.

(ii) Most candidates demonstrated that they knew the equation for efficiency. Some weaker candidates were unclear about which values were useful output energy and input energy and subtracted the values given in the question.

(c) The majority of candidates correctly stated that tidal energy was more regular or more predictable than wind energy or its reverse argument. Weaker candidates referred to locations or environmental issues or stated that tidal was a renewable form energy, not recognising that wind is also a form of renewable energy.

Question 4

(a) A large number of candidates gave a fully correct answer and showed that the differences between evaporation and boiling were well understood. Weaker candidates only gave one difference or contradicted a correct statement about boiling with an incorrect statement about evaporation, e.g. that boiling occurs at constant temperature but evaporation occurs at a temperature above the boiling point. Other weaker candidates did not answer the question and just described the difference between particles in a liquid or a gas.

(b) The strongest candidates gave a logical explanation of the increase in pressure. They began by stating that the number of gas particles increased and/or the kinetic energy of the particles increased. They then stated that this resulted in more frequent collisions with the walls of the cooker, with each collision exerting more force. A further statement said that this results in greater pressure due to pressure being proportional to force gave a complete explanation. Weaker candidates could correctly identify that the kinetic energy of the particles increased and knew the relationship between force and pressure. Incomplete answers stated ‘more collisions’ without a reference to frequency or that force increased but without relating that to the individual collisions.

Question 5

(a) Only the strongest candidates stated clearly that infrared radiation (from the Sun) is absorbed by the tarmac. Partial credit was given for stating that radiation (from the Sun) is absorbed by the tarmac. Many candidates gave unclear statements such as that black is a good absorber of heat without any reference to radiation.

(b) The answer to this question and to **(c)** was a simple one-word statement of a thermal process. Candidates who realised this and gave the answer of conduction gained credit. Many candidates did not understand this and either gave a long explanation of various processes, e.g. diffusion, or gave an incorrect answer of radiation or convection.

(c) Many candidates gave the correct answer of conduction. Weaker candidates gave similar explanations, not worthy of credit, as in the previous question.

(d) To gain full credit for this question candidates needed to give two valid reasons. Many gave one correct answer of the tarmac being a better absorber (of radiation) than the surrounding air. Some candidates correctly stated that air had a higher specific heat capacity than the tarmac or referred to the cooling of the air immediately above the tarmac due to convection.

Question 6

(a) (i) Many candidates correctly identified the wave effect as diffraction. Weaker candidates either omitted this question or gave incorrect answers of longitudinal waves, sound waves or other wave effects, e.g. reflection.

(ii) Most candidates were able to rearrange the equation $v = f \times \lambda$ to calculate the frequency with the correct unit. Weaker candidates gained partial credit if they stated the correct equation but rearranged it incorrectly. The weakest candidates started from an incorrectly rearranged equation, usually $f = v \times \lambda$.

(iii) Candidates needed to realise that a higher frequency of sound produced a lower wavelength so that there would be less diffraction for the higher frequency and that the lower frequency sound had a similar wavelength to the width of the doorway and so would experience large diffraction. Stronger candidates stated that higher frequency caused shorter wavelength and less diffraction. Only the strongest candidates compared the width of the doorway with the wavelength. A common misconception was that the higher frequency sound would be more difficult to hear because it was nearer to the limit or above the limit of human hearing.

(b) The strongest candidates correctly drew a ray from the student to the point X and a ray from X to the teacher. They drew a mirror in the correct position to show angle of incidence = angle of reflection and placed arrows in the correct direction on one or both of the rays. Common errors were drawing the rays to and from a point other than X, the rays missing the teacher or student, omitting the mirror or its label, attempting to draw a 3-D mirror or the mirror at an incorrect angle.

Question 7

(a) Only the strongest candidates gave a precise definition of electromotive force (e.m.f) as the work done in moving a unit charge around a circuit. Some candidates confused the definition with the definition of potential difference. Weaker candidates often simply stated that electromotive force is a voltage or omitted a reference to unit charge. The weakest candidates stated that electromotive force was a force and not work done or a transfer of energy. Some candidates gained partial credit for answers that referenced the work done in moving charge.

(b) The majority of candidates gave the correct value for the p.d. across the heater. Common errors were the omission of the unit, treating the circuit as a series circuit and so dividing the e.m.f. by 2 or dividing the e.m.f. by the resistance.

(c) Most candidates correctly calculated the current and gave a correct unit. Candidates who gave an incorrect value in **(b)** rarely used that value, indicating that there was a misunderstanding of what is meant by potential difference. Candidates recognised that *V* in the equation $V = I \times R$ was the value given for the e.m.f. in this part of the question.

(d) Candidates needed to recognise that the sum of the currents in a parallel circuit would be the current passing through the ammeter. Many candidates successfully added the currents in the heater and the motor. Stronger candidates gave an acceptable explanation of the currents being added together by referring to the total current being the sum of the currents in the branches, often by referring to the current in the heater and the current in the motor being added together to give the current in the ammeter. Weaker candidates used the terms 'series' or 'parallel circuits' incorrectly and often subtracted the currents. A significant number of candidates did not attempt to answer this question.

Question 8

(a) Most candidates answered this question correctly. Common errors included ultraviolet, radio waves, longitudinal waves or echo.

(b) Many candidates correctly calculated the time taken for the boat to receive the reflected wave. They recalled and rearranged v = s / t. They substituted numbers correctly allowing for the full distance travelled being double the distance between the boat and seabed. Finally they gave their answer to two significant figures. Some weaker candidates were unable to rearrange the equation correctly.

(c) This question required candidates to state that either it took a shorter time for the sound to be received back from the fish than from the seabed with the explanation that the fish was closer to the boat, or to state that the reflected wave from the fish would be weaker or have a smaller amplitude as the fish is smaller. Stronger candidates usually gained credit by describing the time difference due to the difference in distance. Weaker candidates gave incorrect responses of changes to wavelength, frequency or velocity of the wave.

Question 9

(a) Candidates were expected to apply their knowledge of electromagnetism to describe the magnetic field in the coil of wire connected to an a.c. supply. The strongest candidates were given full credit for two correct statements about the magnetic field from the following; the direction changes, the magnitude continually changes, the direction being perpendicular to the coil or the strength being stronger near the centre of the coil. Weaker candidates often stated that the magnitude is constant suggesting a lack of understanding of the word 'magnitude'.

(b) (i) To answer this question well candidates needed to apply their knowledge of transformers. A significant number of candidates made a correct reference to induced current. Weaker candidates used the term 'produced' instead of 'induced' and this was insufficient. Fewer candidates referred to the secondary coil being in the magnetic field of the primary coil or in a changing magnetic field. Weaker candidates made references to other properties of transformers, not relevant to this question, e.g. relationships between voltages and number of turns or the presence of an iron core.

(ii) Most candidates who gained credit stated that some of the energy was converted to thermal energy. Vague statements of energy loss without specifying thermal energy were insufficient. Some candidates made correct reference to the lack of an iron core.

(c) (i) Most candidates gave a completely correct answer by using $E = V \times I \times t$ or by combining $P = I \times V$ and $P = E$ / t. Common errors included the use of incorrect equations, e.g. $E = I \times t$ or $E = t \times V$ or incorrect rearrangement of a correct equation. Some candidates rounded the answer to 5900 s or made mistakes in the unnecessary conversion of time to minutes or hours.

(ii) The majority of candidates were given full credit. Those only gaining partial credit had misread the question as they used the time calculated in **(i)** in place of 60 s. Other weaker candidates omitted the unit or gave an incorrect unit.

Question 10

(a) The majority of candidates correctly stated that carbon-14 contained more neutrons than carbon-12. Stronger candidates went on to state that there were 2 more neutrons in carbon-14 than in carbon-12 or that carbon-14 was unstable. Weaker candidates confused nucleons with neutrons, referred to changes in proton/electron number or simply stated that the atoms had a different number of neutrons.

(b) (i) Only the strongest candidates were able to give a clear description of how the amount of carbon-14 decreases with time. Candidates were awarded partial credit if they referred to the amount of carbon-14 halving in 5700 years without going on to say that it would continue to halve every 5700 years. Some weaker candidates thought that carbon-14 would be absorbed in the ground.

(ii) To answer this question, candidates needed to recognise that the change in the ratio of carbon-14 to carbon-12 atoms indicated that a quarter of the carbon-14 atoms had decayed, which in turn meant that 2 half-lives had passed. Only the very strongest candidates were given full credit and weaker candidates found this very challenging.

(c) A general answer indicating a medical use or an understanding that the isotope would cause less harm (to humans) was sufficient to gain partial credit. Full credit was given for both of these statements or their equivalent. Many candidates stated uses that were not applicable to isotopes with a short half-life, e.g. detecting leaks in pipes. Other common incorrect answers included use in smoke detectors or destroying bacteria.

Question 11

(a) (i) Nearly all candidates gave a correct answer. The most common incorrect answers were Pluto, Mercury or the Moon.

(ii) Most candidates gave the correct answer of Mercury. The most common incorrect answer was Mars.

(b) The majority of candidates were given full credit, by recalling the equation for orbital speed, converting time in days to time in s and calculating the value correctly. Partial credit was given for answers showing a correct conversion of time to s. The most common errors were omitting 2π from the equation, or omitting a conversion, or performing a wrong conversion from days to s.

(c) Most candidates correctly stated that the orbital speed decreased with distance from the Sun. Weaker candidates stated the opposite, possibly confusing the distance of planets from the Sun with distance of galaxies from the Earth and Hubble's law. Another common error was to state the difference in time of orbit and not the speed of orbit.

(d) The strongest candidates correctly identified that the speed of the comet is greatest when it is nearest the Sun, that as the radius of the orbit decreases GPE increases and KE decrease or the reverse argument. Most candidates correctly identified the elliptical orbit of the comet, often on a diagram. Weaker candidates did not make a reference to an energy change and the very weakest made no reference to energy.

PHYSICS

Paper 0625/43
Theory (Extended)

Key messages

Candidates should be reminded to:

- read questions carefully and make sure they are answering the question asked
- set out calculations carefully and logically
- use symbols given in the syllabus
- include the correct unit and the required number of significant figures
- give logical step-by-step explanations
- use a ruler and sharp pencil when drawing straight lines and ensure that their handwriting is legible.

Final answer marks for calculations are only awarded for correct numerical answers and the correct unit. Where either the numerical value is incorrect or the unit is missing or incorrect, credit will only be awarded for working shown.

This syllabus now requires that candidates take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m / s^2).

General comments

The majority of candidates were well prepared for this paper and were able to demonstrate some ability and understanding across the whole range of the content being tested. The areas that were less well answered were the life cycle of a more massive star (**Question 10**) and an understanding of the limit of proportionality for a spring (**Question 2**). For weaker candidates, recall and use of refractive index, the critical angle equation and light year calculations proved challenging.

When using symbols for physical quantities candidates are expected to use those given in the syllabus. Any alternative symbol will only gain credit if it is clearly and correctly defined.

Careful drawing of straight lines, using a ruler and a sharp pencil was required in **Question 4(b)(i)**.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to recall that a vector has direction whereas a scalar does not. Statements such as “a vector has magnitude and direction” were insufficient to gain credit as they could imply that a scalar does not have magnitude.

(ii) Stronger candidates correctly recalled that momentum is mass x velocity. Some candidates felt they needed to write a sentence explaining momentum, but these were often incorrect statements, for example referring to “the force of a mass in motion” or “the speed which a mass can get to”.

(b) (i) Many candidates correctly recalled and rearranged the impulse equation to calculate the initial velocity of the car. Weaker candidates were able to gain partial credit for use of $F = m \times a$ but often were unable to continue to use the acceleration to find the initial velocity. The most common error was using t = 4.0 s or 5.5 s instead of the value given in **(i)**.

(ii) There were many good answers here showing a horizontal followed by a diagonal line. Most of the lines had been drawn using a ruler and were very clear. The command word ‘sketch’ indicates that care should be taken over the proportions in the drawing. Candidates needed to take note of the value of time on the *x* axis and their diagonal line should have crossed this axis in a reasonable place.

Question 2

(a) The majority of candidates were familiar with the standard practical extending a spring using masses. Sketches of the apparatus were useful when labelled and even the weakest candidates were able to label a mass or weight hanging on the spring. Many good answers included a statement about calculating the extension by finding the difference between measurements of the final and initial length. The most common errors were omitting any mention of extension or change in length or omission of a ruler for measuring the length. To show how to calculate the spring constant, candidates’ answers needed to include $k = F / x$ in this form (in words or symbols). Statements such as “rearrange Hooke’s Law to find the spring constant” were insufficient. Some good alternative answers explained clearly how to plot a graph and use the gradient to find the spring constant.

(b) (i) This question proved very challenging for many candidates. There was clear indication that candidates had some recall of the limit, but most answers were imprecise. Many stated that it was the point at which the extension is not proportional to the load, rather than, beyond this point extension is no longer proportional.

(ii) Most candidates were able to recall the equation and evaluate it correctly. The most common error was to omit the unit.

(iii) Stronger answers referred to the large difference in the extensions for the two springs. Many candidates recognised that the extension of Q would bring the length of the stretched spring up to 40 cm which would be just enough for the baby to touch the floor. Whereas spring R would extend so much that the baby would collapse on the floor. Candidates were expected to use previously given or calculated information to support them in their answer. Answers referring to Q being safer were insufficient unless the answer explained why. Weaker candidates were often able to select the correct spring but unable to give any explanation.

Question 3

(a) (i) This was generally answered well, and many candidates were able to recall that black is a better absorber. Answers such as “black absorbs radiation” were insufficient because other colours do so too. Answers needed to clearly state that black would be better at absorbing. A misconception that appeared a significant number of times was that black ‘attracts’ heat.

(ii) There were many good answers explaining that the water would not heat up at night or on a cloudy day. A few answers such as “it will be affected by weather” were too vague.

(b) Again, this was very well answered by the majority of candidates. The most common correct answers were wave and wind. Abbreviation or shortening of keywords should always be avoided. Candidates should use hydroelectric or hydropower rather than hydro, which is too vague.

(c) Weaker candidates gained credit for calculating the temperature rise and, in many cases, the energy gained by the water. Stronger candidates also recognised that this was 60% of the energy incident on the bag and were confident in calculating the total energy incident on the bag. The most common error was to multiply the energy gained by the water by 0.6 rather than dividing. Other candidates found the total energy incident on the bag, but then went on to mistakenly calculate 40% of that value. Weaker candidates would have benefitted from writing down the efficiency equation and substituting in known values.

Question 4

(a) (i) Most candidates attempted an answer but only the very strongest knew that both the speed and wavelength would decrease whilst the frequency would remain unchanged. Many other candidates thought that the frequency would change.

(ii) Stronger candidates wrote down the equation sin 45 / sin 30 and evaluated the answer to obtain 1.41. For a 'show that' question, candidates must always rearrange any equation they are using to make the variable they are trying to find the subject of the formula before evaluating. Weaker candidates did not recall the equation correctly and either divided 45 by 30 or omitted an answer.

(iii) Most candidates were able to recall the equation relating critical angle to refractive index and manipulated it to gain the correct answer with a unit. The weakest candidates did not know the equation or confused it, swapping sin *n* for sin *c*, or they omitted the sine. Some candidates tried subtracting 30 from 45, 90 or 180.

(b) (i) Stronger candidates used a ruler to draw the diagram and took care to make the angle of incidence equal to the angle of reflection where the ray hit the edge of the fibre. This resulted in only 2 or 3 reflections along the fibre length. Weaker candidates often drew a zig zag pattern along the fibre with eight or more reflections and were inaccurate.

(ii) There were many correct answers with endoscope, internet transmission or transfer of data being the most common. Some candidates gave answers that were too vague, e.g. communication or medical procedures/equipment. WI-FI was a common incorrect answer.

Question 5

(a) (i) The majority of drawings were clear with four arrows evenly spaced around the sphere. Occasionally candidates attempted to draw the magnetic field pattern that would be around a bar magnet, or they drew arrows which were pointing away from S instead of towards it. A few diagrams were drawn without care, or a ruler, and the field lines were far from being radial. Field lines should continue right up to the boundary of the sphere without a gap.

(ii) Many candidates gained full credit here. A few answers described what was happening to the negatively charged particle and what the nature of the forces were rather than stating a direction. The command word 'state' does not require any explanation or description.

(iii) Most candidates were able to say that the particle will move away from the sphere or be repelled away from it. A completely correct answer required candidates to recognise that the unbalanced force on the particle will cause it to accelerate. Of those candidates who mentioned acceleration, many of them went on to incorrectly say that the particle will slow down or decelerate as it gets further away from the sphere, whereas the acceleration will decrease with distance from the sphere as the field gets weaker. This indicated a confusion around Newton's Laws and deceleration in this unfamiliar situation.

(b) (i) Few candidates understood that the positive paint particles would be repelling each other. The most common incorrect statement referred to the attraction between the positive paint and the negative sphere.

(ii) This was a challenging question. Many candidates could state a suitable advantage (e.g. a more even coat) but few could give enough detail for the explanation. Many answers referred to the positive charges attracting to the negative sphere but did not go on to make a link between this statement and their advantage. Answers saying that the paint sticks more easily or that paint goes on straight away were too vague. Candidates needed to remember that they were comparing the charged method with using a hand brush, so it needed to be a clear advantage over that method.

Question 6

(a) (i) The most common correct answer was to say that if one resistor fails the others will keep working. Some answers referred to bulbs rather than resistors despite resistors being in the question. "If any part of the circuit breaks, then the rest will keep on working" was too vague. Many answers referred to the voltage being the same across all the resistors but needed to state that this was 12V, since the voltage would also be the same across the resistors in series.

(ii) This was answered well and most candidates understood that the water particles would gain energy and the water would evaporate. Weaker answers omitted to mention particles or confused boiling with evaporation. The strongest candidates showed excellent understanding, stating that the heater would transfer energy from its thermal store to the particles and they would gain (kinetic) energy.

(b) (i) Many candidates correctly calculated the current using $V = I \times R$. Common issues were trying to find the total current through the battery by calculating the total resistance of the circuit, or calculating the current in P.

(ii) This question was answered well with many candidates using $E = V \times I \times t$. Weaker candidates often calculated the charge flowing in the time but were unable to proceed further. Those candidates were often able to gain credit for converting the time to seconds.

(iii) Most candidates knew that chemical was the correct answer. The most common incorrect answer was electrical.

(iv) Most candidates recalled and manipulated the equation to calculate the correct total resistance with the correct unit. Weaker candidates did not write the subject of the equation for resistors in parallel correctly as $1 / R_T$, or omitted it entirely, so were unable to gain credit for their working when needed. A common mistake was to forget to invert their value for $1 / R_T$ to find R_T. A significant number of candidates rounded their answer of 39.375 to 40 Ω. Answers should be rounded to two or more significant figures.

Question 7

(a) (i) Most candidates were able to recall the equation for calculating a moment and gave the correct answer.

(ii) Most candidates understood that the clockwise moment would equal the anticlockwise moment when the barrier arm is in equilibrium. They were able to use their answer to **(i)** and rearrange to calculate the distance between the pivot and the joint. The most common error was forgetting to convert 23 kg into newtons. Candidates needed to use g = 9.8 N / kg for their conversion.

(b) (i) Many candidates demonstrated a good level of understanding of electromagnetism. Most were able to correctly state that the barrier arm would rise or rotate anticlockwise because the iron bar was being attracted downwards by the coil. Some answers did not explain that when the current flows through the coil, it produces a magnetic field, and this was just assumed by these candidates. A few candidates mistakenly thought that when the switch is closed the current is off and stops flowing. Consequently, their explanations were reversed. There was confusion with induced current or EMF in some answers.

(ii) A large number of candidates recognised that the force on the iron bar would be smaller due to the decrease in the strength of the magnetic field. Answers referring to a weaker magnet were insufficient. It is the field which is weaker. Only the strongest candidates gained full credit for understanding that the weaker field or force would make the barrier rise more slowly. The most common error was to suggest that the barrier would only rise a little.

(iii) Many candidates were able to answer this question accurately and applied their knowledge that steel forms a permanent magnetic field to this situation. They could see that the barrier would be prevented from returning to the horizontal position. Some answers incorrectly suggested that steel was non-magnetic.

Question 8

(a) (i) Many candidates appeared familiar with the concepts of fission and fusion but their answers lacked clarity and accuracy. Answers needed to be written in terms of the nuclei and not the atoms. If candidates are comparing fission and fusion in terms of the energy released, it must be clear whether it is the energy per reaction or per kilogram of fuel to which they are referring.

(ii) Many answers gave the correct values for the proton and nucleon numbers. A few candidates incorrectly gave Boron a nucleon number of 5. The very weakest candidates were unable to recall the values for an alpha particle or apply the information from the question to Boron.

(b) Many candidates were able to gain partial credit for their recall of the ionizing or penetrating ability of alpha or beta radiation. They needed to take care to apply this information to the situation in the question. Statements referring to alpha being stopped by paper did not apply here. Stronger candidates went on to apply the recall and suggested that alpha particles would destroy the cancer cells more easily or would not travel beyond the cancer cells to damage other healthy cells.

(c) There were many strong answers referring to the use of lead shielding or moving to a different room. A common error was to refer to the use of tongs, gloves or storage in a lead box. However, in a hospital radiotherapy situation sources are not handled.

Question 9

(a) The majority of candidates were able to correctly identify the two wavelengths from the diagram.

(b) Most answers referred to redshift and a high number of candidates gained full credit for relating that to galaxies receding from the Earth. A misconception among weaker candidates was that the expansion of galaxies causes the redshift. A few candidates gave answers about blueshift.

(c) Many candidates gained partial credit for stating that the universe is expanding. Only stronger candidates related the trend in the data in the table to increased redshift with distance and so to increased speed of recession with distance. The question asked what the data showed about the motions of the galaxies, so those answers which just described the trend in terms of wavelength without linking that to speed were insufficient.

Question 10

(a) Stronger answers described how, when the more massive star runs out of hydrogen fuel, it will expand to form a red supergiant. This will then explode as a supernova leaving behind a black hole at the centre. This proved to be a challenging question with only the very strongest candidates gaining full credit. Answers often lacked the detail required, e.g. referring to running out of fuel without mentioning hydrogen or helium. A common misconception was to think that the super red giant was the more massive star referred to in the question. Few candidates understood that when a super red giant explodes as a supernova, the core that is left behind will collapse to form the black hole whilst the nebula is thrown out into space. Imprecise answers stated that the supernova turns into a black hole. A better description would have been that the supernova leaves behind a black hole (at the centre).

(b) (i) Stronger candidates were able to give clear and concise definitions of a light year in terms of distance. Weaker answers often suggested it was the distance from a planet to the Earth or similar. Others said it was a way of measuring distance between planets but gave no additional detail. There was confusion in some answers suggesting it is a measurement of time. A number of candidates did not attempt this question.

(ii) Stronger candidates were able to either recall the distance of one light year in metres or were able to calculate it using the speed of light. A common error during the calculation was to incorrectly convert from metres to kilometres or to forget to multiply by 7800 after calculating the distance for one light year. Weaker candidates tried to apply the Hubble constant in some way or made no attempt at the question.

PHYSICS

Paper 0625/51
Practical Test

Key messages

- Candidates need to have had a thorough grounding in practical work during the course, including reflection and discussion on the 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 borne in mind when explanations, justifications or suggested changes are required, for example in Questions **1(c)**, **1(d)**, **1(e)**, **1(g)**, **2(e)** 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 the candidate.

Comments on specific questions

Question 1

(a) Most candidates recorded a t value within the acceptable range and calculated the period T correctly.

(b) Most candidates recorded the additional values correctly. It was expected that both values of T^2 should be given to the same number of significant figures. Two, three or four significant figures were acceptable.

(c) Candidates were expected to explain that when measuring the total time for 10 oscillations, the possible timing error becomes less significant. This should not be confused with taking 10 separate measurements of one oscillation and then taking an average.

(d) Candidates were expected to show understanding of the use of a set square as a horizontal aid or using the meter ruler close to the pendulum bob.

(e) Candidates were expected to explain use of a fiducial aid or counting as the pendulum passes the vertical.

(f) Although many candidates gave a realistic value for x, a significant minority gave an answer that could have been the distance from the bottom of the support to the bench or the distance from the pendulum bob to the bench.

(g) Candidates were expected to suggest at least three additional values for d. The second mark was awarded to those candidates stating all their values between 25 cm and their value of x.

Question 2

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

(b) (i) Most candidates recorded decreasing temperatures although some recorded a temperature at time 0 that was lower than the temperature after half a minute of cooling.

(ii) A minority of candidates correctly used the unit minutes for the time column. Most candidates used seconds (s).

Candidates should be advised to read the question with care and not to assume that a similar response to that in a past paper is required.

(c) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates started the temperature axis at the origin (0, 0) which resulted in plots that used only the top part of the grid. Plotting was generally accurate. Candidates should use neat crosses (×) for the plots, or neatly circled dots (⦿) so that the accuracy of the plotting can be assessed. Most candidates obtained a realistic set of readings that resulted in plots producing a clear curve. Nevertheless, 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 write a statement that matched the shape of their graph line. The explanation needed to match both the statement and the line. Candidates who obtained the expected curve were able to comment that the slope of the curve was decreasing.

(e) Candidates were expected to know that the scale is read at right angles to avoid a parallax error. Candidates unfamiliar with that term were given credit for an explanation that explained a parallax error.

Question 3

(a) Most candidates obtained a value for h_O within the acceptable range and the majority of those included the appropriate unit (cm or mm).

(b) Most candidates obtained a realistic value for the image distance.

(c) The calculation of focal length was completed successfully by many candidates. An answer to two or three significant figures was expected with the appropriate unit.

(d) In this part, many candidates correctly observed that the image is inverted and magnified.

(e) The two values of focal length f should be equal to within 10 per cent. A significant number of candidates did not achieve this which is probably due to not moving the screen to the position giving the most clearly focused the image.

(f) Candidates were expected to write a statement that matched their results with an explanation of why they 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.

Question 4

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

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

Candidates were required to complete the circuit diagram using the correct symbols for an ammeter and a variable resistor, both in series with the rest of the circuit.

Candidates needed to identify the variable to be tested. The question stated that the fuse wires all had the same length. Therefore, the two possible variables are the diameter of the fuse wire and the metal of the fuse wire. Candidates needed to choose one of these to test and the other to keep constant. Unfortunately, some candidates chose to investigate the resistance of the variable resistor.

For the method the candidates needed to adjust the current (using the variable resistor) and take the current reading at the moment when the fuse melted. The procedure should then be repeated with different diameters or different wire materials (but not both) depending on which variable was chosen to be investigated. A vague reference to repeating is not sufficient as it is not clear whether the test variable has been changed.

Many candidates drew a suitable table. They were expected to include columns for their chosen variable and current with the appropriate unit.

Candidates were expected to explain how to reach a conclusion by drawing a graph of the diameter variable against current. or a bar chart of current against metal. or by comparing values from the table. 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 achieve well in this examination, candidates need to have a thorough grounding in practical work during the course. Candidates should have plenty of personal experience of carrying out experiments. 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, still causes difficulty for many candidates.

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

Many candidates seem less able to derive conclusions backed up by evidence, or to present their conclusions with clarity.

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 even if the change has been approved by Cambridge.

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

Comments on specific questions

Question 1

(a) A complete set of values for the length, width and height of the stack of microscope slides was almost always recorded.
Most candidates recorded their measurements to the nearest millimetre. The stem of the question was sometimes mis-read, and values were sometimes quoted to the nearest centimetre.

(b) The mass of the block was recorded by all candidates, but the instruction to record the mass to the nearest 0.1 g was often ignored.

The subsequent calculation of the density of the block was usually carried out correctly, but the unit of the answer proved to be troublesome to some candidates.

Incorrect units of density seen were g, cm^3, cm^3 / g, N / cm^3.

(c) Candidates were required to use the measurements that they had taken, and information supplied by the supervisor about the mass and the thickness of an individual microscope slide, to determine the number of slides, *N*, in the stack by two different methods.

Most candidates were able to do this, and obtained partial credit for the method used, but a significant number of these candidates did not round their answers to an integer.

Non-integer values correctly rounded up or down to the nearest integer were accepted.

(d) Although questions like this have been set in the past, this was the first time that candidates were asked to justify their statement with a calculation.

Candidates were asked to state whether their values of N_1 from part **(c)(i)** and N_2 in part **(c)(ii)** could be considered to be equal within the limits of experimental accuracy, having been told that this is true if their values are within 10 per cent of each other. It was pleasing to see that many candidates were able to do so. The easiest way to show this, is to calculate the ratio of the smaller of the two values to the larger. If the value obtained is 0.9 (90 per cent) or greater, then the quantities can be considered to be equal.

Another equally acceptable method is to calculate the ratio of the difference between the two values to either of these values. If the answer obtained is 0.1 (10 per cent) or less, then the quantities can be considered to be equal. Other acceptable methods of doing this were also seen.

If both values of *N* recorded by candidates were equal, it was sufficient to state just that, to obtain full credit.

(e) Candidates had difficulty in suggesting a reason why the two estimated values of *N* obtained from the two methods may be different. Many answers referred to poor experimental practice, such as incorrect measurement of the dimensions of the stack of slides or the mass of the slides.

Many mentioned parallax errors, which are not really appropriate here.

The most common creditworthy answers seen, were that the slides may not all have the same mass/thickness or that the tape used to bind the slides together to make the stack, adds to the mass/height of the stack.

Question 2

(a) Almost all candidates recorded a sensible value for the potential difference across the 220 Ω resistor when the switch was closed and recorded the reading in the correct box in Table 2.1.

(b) The instructions to disconnect the voltmeter from the resistor and then reconnect it across the LED were usually followed correctly.

Most candidates obtained a sensible value for the potential difference across the LED when the switch was closed and recorded the reading in the correct box in Table 2.1.

(c) The current in the circuit was almost always calculated correctly using the equation provided.

(d) The resistance of the LED was usually calculated correctly.

Candidates were asked to record the resistance to a suitable number of significant figures for this experiment. It was pleasing to see that most answers were recorded correctly to two or three significant figures.

The missing units from the headings of the table were almost always inserted correctly.

(e) Candidates were required to repeat all the measurements that they had already taken, but with the 220 Ω resistor replaced with a 330 Ω resistor.

Most candidates produced a full set of new values, and their results usually indicated correctly that the resistance of the LED had increased.

(f) Candidates were asked to use the results they had collected in Table 2.1 to describe how the change in current affected the potential difference across the LED and the resistance of the LED. This presented no problems to the more able candidates, but many candidates found it difficult to express in words, what the numerical values in Table 2.1 indicated.

There were a lot of ambiguous responses such as ‘increases’ or ‘decreases’ which failed to link this to any mention of increasing/decreasing current. Responses simply stating that they are directly/inversely proportional also failed to get credit.

(g) Many candidates were unable to make a sensible suggestion as to what the student may have done incorrectly, when the circuit that they had set up did not work. The most common incorrect answer was that the switch had not been closed, despite being told that the circuit was complete. The most common correct answer was that the LED or the power supply had been connected the wrong way around. Another acceptable answer, occasionally seen, was that the voltmeter had been connected in series into the circuit.

Question 3

(a) The image distance *v* was almost always recorded to the nearest 0.1 cm, as requested.

(b) The image was usually drawn correctly – inverted and magnified.

The magnification of the image was usually calculated correctly. A minority of candidates rounded off their answers to one significant figure or supplied a unit with their answer, both of which were penalised.

(c) The procedure was repeated by most candidates using different values of object to lens distances, and most tables were complete. Occasionally, the values of the image distance *v* increased with increasing object distance, showing that the candidate had not followed the detailed instructions supplied.

(d) 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 by the candidates and more difficult for Examiners to check the candidates' plotted points.

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 curves produced by candidates. However, there were still too many graphs where the candidate's attempt at a best-fit curve resulted in all points which did not lie on the drawn curve, being on the same side of the curve. There were also some graphs where the points were joined dot-to-dot. The concept of best fit is clearly still not well understood by all candidates.

(e) The majority of candidates were able to use the graph to find the value of v when u = 30.0 cm. It was pleasing to see that most candidates did as instructed and, showed clearly on the graph how they obtained the necessary information.

(f) The focal length of the lens was usually calculated correctly by candidates inserting their measured values for u and v into the given equation. Most values for the focal length calculated by candidates were within the tolerance range for accuracy allowed.

(g) Better candidates were able to describe a technique that they used to ensure that the image they obtained on the screen was as clearly focussed as possible. The most popular correct answer was to move the screen slowly, or to move the screen backwards and forwards until the image was as sharp as possible. Many candidates stated that they would move the object or the lens slowly or backwards and forwards. Such answers gained no credit because in the experimental arrangement used, the object and the lens were fixed in position.

Question 4

This question discriminated well, with the full range of marks being awarded to candidates.

One mark was available for candidates 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 stopwatch and a thermometer, but only a minority stated that they would also need a ruler/measuring tape to measure the diameter of the beaker.

Two marks were available for giving a brief explanation of how the investigation would be carried out.
Most candidates scored these marks by giving a description of timing hot water cooling in a beaker and then repeating the process with beakers of different diameter.

Candidates had little trouble in suggesting a key variable to control during the experiment. The most popular answers were the mass/volume of the water or the initial temperature of the hot water in the beaker.

Most candidates scored the table mark by drawing a table of results with clear columns for diameter/d and time/t or diameter/d and temperature/θ with appropriate units. It should be noted that 'secs' is an inappropriate unit for time and 'm' is an inappropriate unit for minutes.

Fewer candidates explained satisfactorily how they would <u>use</u> their results to reach a conclusion, because they made predictions about the outcome. An answer such as 'compare the results to see <u>if/how</u> the diameter of the beaker affects the rate of cooling is required.

Many of the better candidates also suggested plotting a graph of diameter against time or diameter against temperature (decrease) or diameter against the rate of cooling.

A further mark was also available for candidates who made one of the following additional points:
1 stating a second control variable
2 stating that at least five sets of data should be taken
3 stating that each measurement taken should be repeated, and an average found.

PHYSICS

Paper 0625/53
Practical Test

Key messages

Candidates need to have experience of practical work during the course. This should include what is needed to improve reliability in experimental work and how to identify which variables need to be controlled.

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

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

All questions should be read carefully so that they are fully understood, and appropriate answers can be given.

General comments

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

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

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

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

Comments on specific questions

Question 1

(a) (i) Most candidates answered this correctly, but a few did not allow the temperature to rise to its highest value before starting the time.

(ii) Most candidates gained full credit here.

(iii) Many candidates were able to identify that the water volume was estimated but few identified the source of this inaccuracy, e.g. no 75 cm^3 marking on the beakers.

(b) Most candidates correctly stated that the larger beaker would cool faster, but many could not be awarded full credit because they did not use any values from the table. A common error was to refer only to the surface area rather than the size of the beaker.

(c) Most candidates answered this correctly with the most common responses being room temperature, volume/amount of water or initial/starting temperature of the water. The most common error was just stating 'initial temperature'.

(d) Almost all candidates performed a correct calculation, with correct units seen. However, some candidates omitted any units.

(e) (i) Most candidates suggested a lid or cover on the top or insulation around the sides. A common error was to suggest other factors, such as the size of the beaker or starting temperature.

(ii) Many candidates suggested that a decrease in cooling rate would be seen but only the strongest candidates gained full credit here.

Question 2

(a) Most candidates read the voltmeter correctly,

(b) Most candidates correctly recorded ascending results, giving all readings to 2 decimal places.

(c) Most candidates correctly labelled the axes, with very few reversed axes seen and only a few candidates did not label them at all. Most candidates used a correct scale, with very few non-linear scales seen. Better scales were seen when candidates did not start their scales from the origin, as indicated on the question paper.

Most candidates were able to plot the points correctly. Candidates should be advised to use crosses when plotting points and should avoid using large blobs.

Most candidates drew a well-judged line. However, a common error was that the lines were too thick. A few candidates drew a forced line through the origin and could not be awarded credit.

(d) (i) The triangle method was used by many candidates to calculate the value of G. A small minority left their answer as a fraction and could not be awarded credit.

(ii) Only stronger candidates answered this correctly with a significant number of answers being out of range due to incorrect substitution in the given equation.

(e) Only a few candidates gained credit here with most answers referring to poor experimental practice, e.g. misreading the voltmeter.

(f) Very few candidates answered this correctly. There were many answers describing other ways of cooling the wire e.g. an ice bath or a fan. Several answers suggested wrapping the wire with insulation.

Question 3

(a) Almost all candidates successfully drew the normal and measured the angle to the required accuracy.

(b) Many candidates had the required minimum pin separation of 5 cm or more. Many correct ray diagrams were seen.

(c) Most candidates correctly measured the lengths to an accuracy of 0.1 cm and then calculated the refractive index successfully.

(d) There were many correct diagrams drawn.

(e) (i) Most candidates gave an answer that was within range.

(ii) The majority of candidates gained partial credit, but a large number did not show any calculation to justify their statement.

(f) A few candidates answered this correctly. Other candidates referred to using a dark room**,** a thin beam of light or observing perpendicularly, which gained no credit.

Question 4

When answering this question, candidates should be aware that using the bullet points is a very good way of ensuring they cover all elements of the investigation.

Most candidates had a good understanding of the experimental procedure required. There were a number of candidates who planned on measuring the distance travelled after the trolley left the ramp, rather than calculating the speed. Very few candidates stated that a protractor was needed as additional apparatus, even though they then proceeded to use it correctly. All additional apparatus needed to be stated.

Overall, the plan was well answered, but repeating for different angles was not always clearly stated. Many candidates either repeated each angle and found an average or repeated the experiment for at least 5 angles. Most candidates identified that a source of inaccuracy was the human reaction time. Most candidates stated that keeping the distance the same was a control variable. Many candidates did not gain credit for the table because units were missing or did not include a column for time. Most candidates did not carry out a successful analysis. A graph, with correct labelled axes, was the most common way that this credit was awarded.

PHYSICS

Paper 0625/61
Alternative to Practical

Key messages

- Candidates will need to have had a thorough grounding in 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 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 are not appropriate to the questions in front of them.

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

Comments on specific questions

Question 1

(a) Most candidates calculated the period T correctly and successfully obtained T^2.

(b) Most candidates recorded the additional values correctly. It was expected that both values of T^2 should be given to the same number of significant figures. Three or four significant figures were acceptable.

(c) Most candidates gave the unit s for the period T but many gave s instead of s^2 for T^2.

(d) Candidates were expected to explain that when measuring the total time for 10 oscillations, the possible timing error becomes less significant. This should not be confused with taking 10 separate measurements of one oscillation and then taking an average.

(e) Candidates were expected to show understanding of the use of a set square as a horizontal aid or using the meter ruler close to the pendulum bob.

(f) Candidates were expected to explain use of a fiducial aid or counting as the pendulum passes the vertical.

(g) Although many candidates gave a realistic value for x, a significant minority gave an answer that could have been the distance from the bottom of the support to the bench or the distance from the pendulum bob to the bench or a measurement from the diagram.

(h) Candidates were expected to suggest at least three additional values for d. The second mark was awarded to those candidates stating all their values between 25cm and their value of x.

Question 2

(a) Most candidates showed the value for room temperature successfully.

(b) A minority of candidates correctly used the unit minutes for the time column. Most used seconds (s). Candidates should be advised to read the question with care and not to assume that a similar response to that in a past paper is required.

(c) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates started the temperature axis at the origin (0, 0) which resulted in plots that used only the top part of the grid. Plotting was generally accurate. Candidates should use neat crosses (×) for the plots, or neatly circled dots (⦿) so that the accuracy of the plotting can be assessed. Most candidates obtained a realistic set of readings that resulted in plots producing a clear curve. Nevertheless, 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 write a statement that matched the shape of their graph line. The explanation needed match both the statement and the line. Candidates who obtained the expected curve were able to comment that the slope of the curve was decreasing.

(e) Candidates were expected to know that the scale is read at right angles to avoid a parallax error. Candidates unfamiliar with that term were given credit for an explanation that explained a parallax error.

(f) Candidates were expected to draw a recognisable measuring cylinder with the water level shown. Some drew a beaker whereas others drew a careless diagram that showed a test-tube with graduations. Candidates were expected to show clearly that the line of sight is at right angles to the measuring cylinder and lined up correctly with the water level.

Question 3

(a) Most candidates obtained the correct value for h_O and the majority of those included the appropriate unit (cm or mm).

(b) Candidates were expected to explain how to find the best position by moving the screen slowly back and forth and to have a darkened room (or bright object).

(c) The calculation of focal length was completed successfully by many candidates. An answer to two or three significant figures was expected with the appropriate unit.

(d) In this part, many candidates correctly stated that the image is inverted and magnified.

(e) Many candidates calculated the focal length correctly.

(f) Candidates were expected to write a statement that matched the results with an explanation of why they could or could not be regarded as equal within the limits of experimental accuracy. For example, if the results were similar (the result obtained from correct working), the candidate could comment that they were within 10 per cent of each other, or very close to each other.

Question 4

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

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

Candidates were required to complete the circuit diagram using the correct symbols for an ammeter and a variable resistor, both in series with the rest of the circuit.

Candidates needed to identify the variable to be tested. The question stated that the fuse wires all had the same length. Therefore, the two possible variables are the diameter of the fuse wire and the metal of the fuse wire. Candidates needed to choose one of these to test and the other to keep constant. Unfortunately, some candidates chose to investigate the resistance of the variable resistor.

For the method the candidates needed to adjust the current (using the variable resistor) and take the current reading at the moment when the fuse melted. The procedure should then be repeated with different diameters or different wire materials (but not both) depending on which variable was chosen to be investigated. A vague reference to repeating is not sufficient as it is not clear whether the test variable has been changed.

Many candidates drew a suitable table. They were expected to include columns for their chosen variable and current with the appropriate unit.

Candidates were expected to explain how to reach a conclusion by drawing a graph of the diameter variable against current. or a bar chart of current against metal. or by comparing values from the table. The question did not ask for a prediction. Some candidates wrote a prediction but no explanation of how to reach a conclusion.

PHYSICS

Paper 0625/62
Alternative to Practical

Key messages

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

Candidates should be advised to read 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, still causes difficulty for many candidates.

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

Candidates still seem to be less able 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 entering this paper were well prepared and it was pleasing to see that the range of practical skills being tested proved to be accessible to the majority of the candidature. Most candidates demonstrated that they were able to draw upon their own personal practical experience to answer the questions. No parts of any question proved to be inaccessible to all candidates, and there was no evidence of candidates running short of time. Most 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 dimensions of the stack of microscope slides were measured accurately by most candidates.

Most candidates did as requested and, recorded their measurements to the nearest millimetre. The stem of the question was sometimes mis-read, and values were sometimes quoted to the nearest centimetre.

(b) The mass of the block was recorded by all candidates, but the instruction to record the mass to the nearest 0.1 g was often ignored.

The subsequent calculation of the density of the block was usually carried out correctly, but the unit of the answer proved to be troublesome to some candidates.

Incorrect units of density seen were g, cm^3, cm^3 / g, N / cm^3.

(c) Candidates were required to use the measurements that they had made in part **(a)**, and information supplied on a card about the mass and the thickness of an individual microscope slide, to determine the number of slides, *N*, in the stack by two different methods.

Most candidates were able to do this, and obtained partial credit for the method used, but approximately one-half of these candidates did not round their answers to an integer.

Non-integer values correctly rounded up or down to the nearest integer were accepted.

(d) Although questions like this have been set in the past, this was the first time that candidates were asked to justify their statement with a calculation.

Candidates were asked to state whether their values of N_1 from part **(c)(i)** and N_2 in part **(c)(ii)** could be considered to be equal within the limits of experimental accuracy, having been told that this is true if their values are within 10 per cent of each other. It was pleasing to see that many candidates were able to do so. The easiest way to show this, is to calculate the ratio of the smaller of the two values to the larger. If the value obtained is 0.9 (90 per cent) or greater, then the quantities can be considered to be equal.

Another equally acceptable method is to calculate the ratio of the difference between the two values to either of these values. If the answer obtained is 0.1 (10 per cent) or less, them the quantities can be considered to be equal. Other acceptable methods of doing this were also seen.

If both values of *N* recorded by candidates were equal, it was sufficient to state just that, to obtain full credit.

(e) Only approximately 20 per cent of candidates were able to suggest a reason why the two estimated values of *N* obtained from the two methods may be different.

Many answers referred to poor experimental practice, such as incorrect measurement of the dimensions of the stack of slides or the mass of the slides. Many candidates mentioned parallax errors, which are not really appropriate here.

The most common creditworthy answers seen, were that the slides may not all have the same mass/thickness or that the tape used to bind the slides together to make the stack, adds to the mass/height of the stack.

Question 2

(a) Most candidates completed the circuit diagram correctly and showed a voltmeter connected in parallel with the 220 Ω resistor.

The standard symbol for a voltmeter was expected and candidates who carelessly drew a line through a correct symbol were penalised.

The reading on the voltmeter was recorded correctly by most candidates. Common incorrect answers were 2.8 A and 3.6 A.

(b) The current in the circuit was almost always calculated correctly using the equation provided.

(c) The resistance of the LED was usually calculated correctly.

Candidates were asked to record the resistance to a suitable number of significant figures for this experiment. It was pleasing to see that most answers were recorded correctly to two or three significant figures.

(d) Candidates were required to use the information supplied in Table 2.1 to deduce the potential difference across the 330 Ω resistor.

The most common error made by candidates here was to use the resistance of the LED in the calculation instead of the resistance of the resistor.

(e) Candidates were asked to use the results they had collected in Table 2.1 to describe how the change in current affected the potential difference across the LED and the resistance of the LED. This presented no problems to the more able candidates, but many candidates found it difficult to express in words, what the numerical values in Table 2.1 indicated.

There were a lot of ambiguous responses such as ‘increases’ or ‘decreases’ which failed to link this to any mention of increasing/decreasing current. Responses simply stating that they are directly/inversely proportional also failed to get credit.

(f) Most candidates drew the symbol for a variable resistor correctly.

Only the more able candidates were able to give an advantage of using a variable resistor to obtain different values of current in the circuit, rather than replacing the resistor with one of a different value each time.

Candidates seemed to be unaware that an obvious advantage was to avoid disconnecting and then reconnecting the circuit each time that the resistor was changed.

Question 3

(a) The image distance *d* from the centre of the lens to the screen was measured correctly by most candidates to be 12.1 cm.

Most candidates did as requested and recorded their measurements to the nearest 0.1 cm.

Occasionally, answers of 12.10 cm were seen – these answers did not score.

Most candidates understood what was meant by a scale of one-fifth full size and multiplied their value of *d* by five to calculate the actual image distance. Some weaker candidate divided their value of *d* by five.

(b) Most candidates compared the diagrams of the object and its corresponding image and gave two correct comparisons between them.

The magnification of the image was usually calculated correctly. A minority of candidates rounded off their answers to one significant figure or supplied a unit with their answer, both of which were penalised.

(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 by the candidates and more difficult for Examiners to check the candidates' plotted points.

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 curves produced by candidates. However, there were still too many graphs where the candidate's attempt at a best-fit curve resulted in all points which did not lie on the drawn curve, being on the same side of the curve. There were also some graphs where the points were joined dot-to-dot. The concept of best fit is clearly still not well understood by all candidates.

(d) The majority of candidates were able to use the graph to find the value of v when u = 30.0 cm. It was pleasing to see that most candidates did as instructed and, showed clearly on the graph how they obtained the necessary information.

(e) The focal length of the lens was usually calculated correctly by candidates inserting their measured values for u and v into the given equation. Most values for the focal length calculated by candidates were within the tolerance range for accuracy allowed.

(f) Better candidates were able to describe a technique that they used to ensure that the image on the screen was as clearly focussed as possible. The most popular correct answer was to move the screen slowly, or to move the screen backwards and forwards until the image was as sharp as possible. Many candidates stated that they would move the object or the lens slowly or backwards and forwards. Such answers gained no credit because in the experimental arrangement used, the object and the lens were fixed in position.

Question 4

This question discriminated well, with the full range of marks being awarded to candidates.

One mark was available for candidates 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 stopwatch and a thermometer, but only a minority stated that they would also need a ruler/measuring tape to measure the diameter of the beaker.

Two marks were available for giving a brief explanation of how the investigation would be carried out.
Most candidates scored these marks by giving a description of timing hot water cooling in a beaker and then repeating the process with beakers of different diameter.

Candidates had little trouble in suggesting a key variable to control during the experiment. The most popular answers were the mass/volume of the water or the initial temperature of the hot water in the beaker.

Most candidates scored the table mark by drawing a table of results with clear columns for diameter/d and time/t or diameter/d and temperature/θ with appropriate units. It should be noted that 'secs' is an inappropriate unit for time and 'm' is an inappropriate unit for minutes,

Fewer candidates explained satisfactorily how they would <u>use</u> their results to reach a conclusion, because they made predictions about the outcome. An answer such as 'compare the results to see <u>if/how</u> the diameter of the beaker affects the rate of cooling is required.

Many of the better candidates also suggested plotting a graph of diameter against time or diameter against temperature (decrease) or diameter against the rate of cooling.

A further mark was also available for candidates who made one of the following additional points:
1 stating a second control variable
2 stating that at least five sets of data should be taken
3 stating that each measurement taken should be repeated, and an average found.

PHYSICS

Paper 0625/63
Alternative to Practical

Key messages

Candidates need to have experience of practical work during the course. This should include what is needed to improve reliability in experimental work and how to identify which variables need to be controlled. This examination should not be seen as a way that the course can be effectively taught without practical work.

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

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

All questions should be read carefully so that they are fully understood, and appropriate answers can be given.

General comments

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

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

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

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

Comments on specific questions

Question 1

(a) (i) Almost all candidates answered this correctly.

(ii) Most candidates gained credit here for stating that the viewing should be either at eye level or perpendicular, with some incorrectly describing it as ‘parallel’. The most common error was waiting for the reading to reach a peak or settle.

(b) Many candidates were able to identify that the water volume was estimated but few identified the source of this inaccuracy, e.g. no 75 cm^3 marking on the beakers.

(c) Most candidates correctly stated that the larger beaker would cool faster, but many did not get the further credit because they did not use any values from the table. A common error was to refer only to the surface area rather than the size of the beaker.

(d) Most candidates answered this correctly with the most common responses being room temperature, volume/amount of water or initial/starting temperature of the water. The most common error was just stating 'initial temperature'.

(e) Almost all candidates performed a correct calculation, with correct units seen. However, some candidates gave their answer to only 2 decimal places, or incorrectly rounded their answer.

(f) (i) Most candidates suggested a lid or cover on the top or insulation around the sides. A common error was to suggest other factors, such as the size of the beaker or starting temperature.

(ii) Many candidates suggested that a decrease in cooling rate would be seen but only the strongest candidates gained full credit here.

Question 2

(a) Most candidates placed the voltmeter correctly, with only a few placing it in series. A number of candidates did not give an answer to this question.

(b) Almost all candidates answered this correctly.

(c) The vast majority of candidates answered this correctly with only a few recording 0.19.

(d) Most candidates correctly labelled the axes, with only very few reversed axes seen and few candidates did not label them at all. Most candidates used a correct scale, with very few non-linear scales seen. Better scales were seen when candidates did not start their scales from the origin, as indicated on the question paper.

Most candidates were able to plot the points correctly. Candidates should be advised to use crosses when plotting points and should avoid using large blobs.

Most candidates drew a well-judged line. However a common error was that the lines were too thick. A few candidates drew a forced line through the origin and could not be awarded credit.

(e) (i) The triangle method was used by many candidates to calculate the value of G. A few candidates left their answer as a fraction and so could not be awarded credit.

(ii) Only stronger candidates answered this correctly with a significant number of incorrect answers being extremely out of range due to incorrect substitution in the given equation.

(f) Few candidates gained credit here with most answers referring to poor experimental practice, e.g. misreading the voltmeter.

(g) Only stronger candidates answered this correctly. There were many answers describing other ways of cooling the wire, e.g. an ice bath or a fan. Several answers suggested wrapping the wire with insulation.

Question 3

(a) (i) Almost all candidates successfully drew the normal.

(ii) Most candidates correctly measured the angle with the correct units.

(b) (i) Most candidates answered this correctly.

(ii) Many candidates stated that the pin separation was acceptable with other candidates stating either that they were too close or needed to be at least 5 cm apart.

(c) Most candidates drew the lines correctly**.**

(d) (i) The majority of candidates measured the lengths correctly to 0.1 cm, with some being slightly out of range.

(ii) Almost all candidates used their answers from **(i)** to correctly calculate the refractive index.

(e) (i) Most candidates gave an answer that was within range.

(ii) Almost all candidates scored the initial credit, but a large number did not show any calculation to justify their statement.

(f) A few candidates answered this correctly. Other candidates referred to using a dark room**,** a thin beam of light or observing perpendicularly, which gained no credit.

Question 4

When answering this question, candidates should be aware that using the bullet points is a very good way of ensuring they cover all elements of the investigation.

Most candidates had a good understanding of the experimental procedure required. There were a number of candidates who planned on measuring the distance travelled after the trolley left the ramp, rather than calculating the speed. Very few candidates stated that a protractor was needed as additional apparatus, even though they then proceeded to use it correctly. All additional apparatus needed to be stated.

Overall the plan was well answered, but repeating for different angles was not always clearly stated. Many candidates either repeated each angle and found an average or repeated the experiment for at least 5 angles. Most candidates identified that a source of inaccuracy was the human reaction time. Most candidates stated that keeping the distance the same was a control variable. Many candidates did not gain credit for the table because units were missing or did not include a column for time. Most candidates did not carry out a successful analysis. A graph, with correct labelled axes, was the most common way that this credit was awarded.