PHYSICS

Paper 0625/11
Multiple Choice (Core)

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

General comments

Candidates demonstrated very good knowledge of how to read the scale on a measuring cylinder and about particles in solids and gases. However, there were some misconceptions about energy stores. It was evident that radioactive decay and some unit prefixes were not well understood.

Comments on specific questions

Question 1

This question required candidates to read the volume of a liquid in a measuring cylinder. Most candidates were able to read the volume correctly, but some weaker candidates misread the scale as 13.0 cm^3.

Question 8

This question assessed candidates' knowledge of energy stores and was only answered well by stronger candidates. Few other candidates recognised that nuclear fuel does not contain a store of chemical energy, instead they had the misconception that either coal or oil did not contain a store of chemical energy.

Question 9

This question required candidates to calculate work done. The majority of candidates did not use the correct equation to calculate work done as they used the mass of the 20 tiles instead of the weight of the 20 tiles. Most candidates therefore chose option **C**.

Question 14

Most stronger candidates demonstrated an excellent understanding of what happens to the pressure of the gas trapped in a sealed syringe when the plunger is moved outwards. However, many weaker candidates thought that the pressure of the gas would increase due to more frequent collisions between the gas particles and syringe wall, and therefore chose option **D**.

Question 16

Although most candidates interpreted the bar chart correctly, many weaker candidates had the misconception that the more time it took for the pin to fall from a rod, the better the rod was at conducting thermal energy.

Question 19

The majority of candidates found this question challenging as they did not know the difference between a transverse wave and a longitudinal wave. Most weaker candidates thought that sound was an example of a transverse wave.

Question 21

The majority of candidates did not read the question carefully enough to realise that the person was looking at a reflection of the clock in a plane mirror. The most common answer was therefore option **B**.

Question 23

The majority of stronger candidates correctly identified what happens to the loudness and to the pitch of a sound wave when both the amplitude and the frequency increase. Although most weaker candidates recognised that the loudness would increase, a significant number though that the pitch would decrease.

Question 27

Although most candidates appeared to recall that they needed to use the equation $P = VI$, and therefore chose either option **C** or option **D**, the majority of candidates did not recognise the unit prefixes in option **C** and therefore incorrectly chose that option.

Question 35

The majority of candidates found this question very challenging with only some stronger candidates correctly identifying the type of ionising radiation being emitted by the nucleus. However, weaker candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 37

Most stronger candidates recalled that the atomic number is equivalent to the number of protons in a nucleus. However, the majority of weaker candidates had the misconception that the number of protons is calculated by subtracting the atomic number from the mass number, and therefore chose option **B**.

Question 38

Candidates across the ability levels demonstrated very good knowledge of the motion of the Earth on its axis and in orbit around the Sun.

PHYSICS

Paper 0625/12
Multiple Choice (Core)

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

General comments

Candidates demonstrated very good knowledge of work done and changes of state. However, there were some misconceptions about resultant forces and gravitational field strength at the surface of a planet.

It was evident that the effect on gas pressure when the volume of the gas increases and the formation of convection currents were not well understood.

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.

Comments on specific questions

Question 6

This question assessed candidates' knowledge of the effect of resultant forces on an object. Most candidates found this question challenging. The majority of candidates had the misconception that there was a resultant force on the car because it was going downhill, even though it was travelling at constant speed.

Question 7

This question required candidates to recall the equation for the moment of a force, rearrange the equation to calculate force, and to recognise the unit prefix milli. Only stronger candidates were able to do this successfully, with most weaker candidates missing out the unit prefix and therefore choosing option **A**. Candidates could benefit from short activities in lessons where they identify and practise converting between different units and using unit prefixes.

Question 8

The majority of candidates were able to recall the equation for the work done by a force.

Question 12

Many stronger candidates demonstrated an excellent understanding of what happens to the pressure of the gas trapped in a cylinder when the volume is increased. However, there were also many candidates who had the misconception that the pressure would increase due to more frequent collisions between the gas particles and the cylinder. Many weaker candidates had the misconception that when the volume increases, gas particles collide at a higher speed which increases the pressure and therefore chose option **C**.

Question 13

Stronger candidates performed well on this question. Weaker candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 15

Stronger candidates performed well on this question. Weaker candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 17

Due to an issue with **Question 17**, this question has been discounted. Each candidate's total mark has been multiplied by a weighting factor so that the maximum mark for the question paper remains unchanged. The question describes twelve crests of a water wave passing a boat, which equates to 11 wavelengths not 12. The correct answer, option **B**, should therefore have been 0.61 m/s rather than 0.67 m/s. The question has been corrected in the published version of the paper.

Question 20

Most candidates found this question challenging and did not identify which measurement was the focal length of the lens. The most common incorrect answer identified the image distance instead.

Question 23

Most candidates identified that the numbers on the diagram represented the frequency in Hz of the waves.

Question 29

The majority of candidates found it difficult to interpret what happened to the current in the circuit and to the potential difference across the resistor when the thermistor was heated. Most stronger candidates recognised that the current would increase, but many of these candidates thought that the potential difference across the resistor would decrease and therefore chose option **C**. A large number of weaker candidates thought that the current would decrease and the potential difference would increase.

Question 31

In this question, candidates had to calculate current by recalling and rearranging the equation power = current × potential difference and then choose an appropriate fuse size. Only stronger candidates answered this correctly. Weaker candidates mainly chose option **C**, possibly because this was the size of fuse which was closest to, but less than, the current.

Question 39

Although many stronger candidates answered this question correctly, a large number of candidates had the misconception that gravitational field strength depends on atmospheric pressure and therefore chose option **A**.

PHYSICS

Paper 0625/13
Multiple Choice (Core)

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

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

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

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

General comments

Candidates demonstrated very good knowledge of work done and changes of state. However, there were some misconceptions about resultant forces and gravitational field strength at the surface of a planet.

It was evident that the effect on gas pressure when the volume of the gas increases and the formation of convection currents were not well understood.

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.

Comments on specific questions

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This question required candidates to recall the equation for the moment of a force, rearrange the equation to calculate force, and to recognise the unit prefix milli. Only stronger candidates were able to do this successfully, with most weaker candidates missing out the unit prefix and therefore choosing option **A**. Candidates could benefit from short activities in lessons where they identify and practise converting between different units and using unit prefixes.

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Question 13

Stronger candidates performed well on this question. Weaker candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 15

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Most candidates identified that the numbers on the diagram represented the frequency in Hz of the waves.

Question 29

The majority of candidates found it difficult to interpret what happened to the current in the circuit and to the potential difference across the resistor when the thermistor was heated. Most stronger candidates recognised that the current would increase, but many of these candidates thought that the potential difference across the resistor would decrease and therefore chose option **C**. A large number of weaker candidates thought that the current would decrease and the potential difference would increase.

Question 31

In this question, candidates had to calculate current by recalling and rearranging the equation power = current × potential difference and then choose an appropriate fuse size. Only stronger candidates answered this correctly. Weaker candidates mainly chose option **C**, possibly because this was the size of fuse which was closest to, but less than, the current.

Question 39

Although many stronger candidates answered this question correctly, a large number of candidates had the misconception that gravitational field strength depends on atmospheric pressure and therefore chose option **A**.

PHYSICS

Paper 0625/21
Multiple Choice (Extended)

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

General comments

Candidates demonstrated very good knowledge of apparatus required to find the density of a material and how to determine the number of neutrons in an atom. However, there were some misconceptions about the function of the iron core in a transformer and the emission of thermal radiation.

It was evident that uses of satellites and cosmic microwave background radiation were not well understood.

Comments on specific questions

Question 4

This question required candidates to identify the apparatus required to find the density of gold. The majority of candidates were able to identify the correct equipment but some weaker candidates thought that only a balance was required and therefore chose option **D**.

Question 5

Stronger candidates performed well on this question. Weaker candidates struggled to use the information and the correct equation in order to calculate the spring constant of the spring and their responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 11

The majority of stronger candidates used the equation pV = constant correctly. However, weaker candidates had the misconception that if the volume increases by a factor of 1.5, then the pressure would also increase by a factor of 1.5 and therefore chose option **C**.

Question 15

The majority of candidates demonstrated an excellent understanding of thermal conduction.

Question 16

This question assessed candidates' knowledge of the emission and absorption of thermal radiation. Although most candidates correctly recalled that black surfaces are better absorbers of radiation than white surfaces, many of these candidates thought that black surfaces are worse emitters of radiation, and therefore chose option **C**.

Question 22

The majority of candidates found this question about satellites challenging. Although most candidates recalled the correct electromagnetic wave used to receive and re-transmit television signals, a significant number of candidates thought that low-orbit satellites were used instead of geostationary satellites.

Question 26

The majority of candidates knew that as the diameter d of a copper wire increases, the resistance R of the wire decreases, and therefore chose option **C** or option **D**. However, a significant number of candidates did not realise that because R is inversely proportional to the cross-sectional area of the wire, R must be inversely proportional to d^2, and therefore chose option **C** instead of option **D**.

Question 29

This question required candidates to use the right-hand rule in order to determine the direction in which the wire had to be moved to induce a current in the direction shown. Many stronger candidates determined the direction correctly but a significant number chose option **B**, suggesting that they used the left-hand rule instead of the right-hand rule. Weaker candidates' responses were evenly distributed across the four possible options, indicating that many had guessed the answer.

Question 32

This question about the function of the iron core in a transformer was answered well by stronger candidates. A significant number of weaker candidates had the misconception that the iron core was used to conduct current from the primary coil to the secondary coil.

Question 35

Stronger candidates were able to determine the count rate due to a radioactive source after a period of time, taking into account the count rate from background radiation. Weaker candidates realised that they had to subtract the background count rate from the initial reading on the detector but forgot to add the background reading back on at the end, and therefore chose option **A**.

Question 37

This question about safety precautions was very well answered by stronger candidates. However, the majority of weaker candidates thought that reducing the distance between a radioactive source and a person using it was also a precaution and chose option **A**.

PHYSICS

Paper 0625/22
Multiple Choice (Extended)

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

General comments

Candidates demonstrated very good knowledge of the value of the speed of light and how to determine acceleration of an object from a velocity–time graph. However, there were some misconceptions about the motion of a falling ball and the electrical component used to convert a.c. to d.c.

It was evident that half-life of a radioactive material and change of momentum were not well understood by weaker candidates.

Comments on specific questions

Question 2

For this question, candidates had to describe the motion of a ball falling from a building, ignoring the effect of air resistance. Nearly all stronger candidates correctly described the ball as falling with constant acceleration, but a significant number of weaker candidates had the misconception that the ball would fall with increasing acceleration.

Question 6

Candidates found this question very challenging, with only the strongest candidates giving the correct answer. The most common error was that candidates only took into account the tension in the spring, they did not take into account the weight of the mass on the spring to find the resultant force upwards. This lead to the majority of candidates choosing option **B**.

Question 7

Most stronger candidates calculated the change of momentum and the force applied to the ball correctly. The majority of weaker candidates chose option **A** as they only determined the momentum before the impact of the ball on the bat rather than the change of momentum.

Question 19

This question about seismic S-waves was answered well by stronger candidates. However, weaker candidates demonstrated poor knowledge with evidence of guesswork, as the answers were spread across all four options almost equally.

Question 23

Nearly all candidates were able to recall the speed of light correctly, but a few weaker candidates did not look carefully enough at the units and therefore chose option **D**.

Question 24

Stronger candidates determined the correct depth of the sea. Weaker candidates made the common error of not using the correct time in the equation distance = speed × time. They used the time for the pulse to travel to the seabed and back to the ship (which resulted in twice the depth) and therefore chose option **D**.

Question 27

This question assessed candidates' knowledge of how to use a circuit to determine the resistance of a lamp. Stronger candidates were able to identify the change necessary to the circuit provided. Weaker candidates found this more challenging, with many suggesting either connecting the ammeter in parallel with the lamp or swapping the positions of the ammeter and the voltmeter.

Question 30

The majority of stronger candidates recalled that a diode is used to convert a.c. to d.c. However, weaker candidates had the misconception that a transformer is used to convert a.c. to d.c.

Question 36

This question about alpha, beta and gamma radiation was answered well by stronger candidates. However, weaker candidates demonstrated poor knowledge with evidence of guesswork, as the answers were spread across all four options almost equally.

Question 37

Nearly all stronger candidates were able to correctly apply their understanding of half-life to this question, but the majority of weaker candidates had the misconception that once the time equal to two half-lives had passed, all of the radioactive material would have decayed.

Question 39

The majority of stronger candidates could identify the nuclear reaction that releases energy in stars. Although most weaker candidates could recall that nuclear fusion takes place in stars, they were less successful at recalling that hydrogen was converted into helium.

PHYSICS

Paper 0625/23
Multiple Choice (Extended)

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

General comments

Candidates demonstrated very good knowledge of the particle structure of a gas and changes in state. However, there were some misconceptions about weight and the bending of a wave round an edge.

It was evident that transverse waves and the equation for pressure were not well understood by weaker candidates.

Comments on specific questions

Question 4

This question assessed candidates' understanding of weight. Nearly all stronger candidates chose the correct option, but many weaker candidates had the misconception that weight of an object is the quantity of matter in the object rather than the force of attraction between the object and the Earth.

Question 8

This question required candidates to use the law of conservation of momentum when two trucks collided. Most stronger candidates were able to determine the velocity of the two trucks after the collision. Weaker candidates found this question challenging.

Question 10

Most candidates demonstrated excellent knowledge of the particle structure of a gas.

Question 12

This question about gas pressure was answered well by stronger candidates. Most weaker candidates recalled that the gas particles experience a change in momentum when they collide with the walls of a container, but many of these candidates thought that the resulting pressure was equal to force × area.

Question 15

This question assessed candidates' knowledge of the emission of thermal radiation. The majority of stronger candidates correctly answered option **C** but this was the least popular option chosen by weaker candidates. Instead, weaker candidates' answers were spread over the other three options, indicating some guesswork.

Question 18

Candidates appeared to be aware that the wavelengths of the waves had an effect on how much the waves bend but a significant number of candidates had the misconception that the wave of shorter wavelength would bend more than the wave of longer wavelength.

Question 21

The majority of stronger candidates recalled that all electromagnetic waves travel at a speed of 3.0×10^8 m / s in a vacuum. However, a significant number of weaker candidates had the misconception that radio waves travel more slowly than visible light and gamma rays travel faster, and therefore chose option **B**.

Question 25

Many candidates found this question very challenging with most choosing option **C** instead of option **D**. The majority of candidates knew that if the diameter of the second wire was greater, then the length of the second wire would also need to be greater in order to keep the resistance the same, so chose option **C** or option **D**. However, most candidates did not realise that because resistance is inversely proportional to the cross-sectional area of the wire, the resistance must be inversely proportional to the diameter squared. Therefore, because the diameter doubled, candidates only doubled the length of the wire instead of multiplying it by 4.

Question 29

Many candidates found this question about the placement of the fuse and the switch in mains electric wires very challenging. Although the majority of candidates knew that the fuse was placed in the live wire, many candidates incorrectly thought that the switch was placed in the neutral wire.

Question 33

This question assessed candidates' knowledge of alpha particles and beta particles. The majority of candidates knew that alpha particles were less penetrating and/or more ionising than beta particles, but could not explain that this was due to alpha particles having more kinetic energy than beta particles.

Question 37

This question required students to determine the count rate due a radioactive source after a period of time, taking into account the count rate from background radiation. Most stronger candidates found this straightforward. Weaker candidates did not realise they had to subtract the background count rate from the initial reading on the detector. They also forgot to add the background reading back on at the end, and therefore chose option **B**.

PHYSICS

Paper 0625/31
Theory (Core)

Key messages

Some candidates were unclear about what counts as a significant figure. Candidates should be encouraged **not** to round to 1 significant figure and should practise exercises on this topic.

Some candidates' handwriting made it difficult to distinguish what they were writing. There were some issues differentiating between the numbers 1 and 7, 4 and 7, 6 and 0, 9 and 0 and sometimes 4 and 9. Candidates should be encouraged to ensure that working and answers to numerical questions are as clear as possible.

Candidates sometimes needed to be clearer and more precise 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

Most candidates were prepared for this exam. They were able to apply their knowledge and physics understanding to the questions set and to produce correct responses. However, in some cases, answers were confused with unclear use of the pronouns 'it' and 'they'. In addition, candidates frequently stated a property had changed but failed to state how it had changed, i.e. whether it had increased or decreased.

Some areas of the syllabus were better known than others. In particular, applying the principle of moments, comparing thermal conductivity, refraction of light and images formed by a thin converging lens, power calculations, nuclide notation, nuclide terms and half-life were not well understood. Equations were generally well known by all but the weakest candidates. Many candidates understood how to apply equations to standard situations well.

The non-numerical questions were more of a challenge to many candidates than the numerical questions. A noticeable number of candidates struggled to express themselves adequately when answering the extended writing questions.

Comments on specific questions

Section A

Question 1

(a) The majority of candidates correctly identified the largest acceleration as section KL. A common incorrect answer was MN (possibly because that has the longest line). The next most common error was to give only one letter, such as K or L, so not identifying the correct section.

(b) Many candidates scored full credit for determining the distance travelled as 44 m. However, there were many incorrect applications of knowledge. The most common error was in determining the correct time. Other candidates did not use the correct equation for determining the area of a triangle and so 88 m was a frequently seen incorrect answer. A significant number of candidates thought that distance = speed ÷ time.

(c) (i) Most candidates gained credit here with statements equivalent to 'constant speed'. A common incomplete answer was 'constant' or 'constant motion' without stating what was constant. A number of candidates confused the graph with a distance–time graph and thought the car was at rest.

(ii) Most candidates correctly stated deceleration in some way or other. A few candidates answered 'decreasing' but failed to state what was decreasing. A few gave very comprehensive answers such as decelerating from 20 m / s to zero velocity in 15 s.

(d) This question was answered well by the majority of candidates. Almost all candidates knew that they needed to divide total distance (500 m) by total time (20 s) to get the answer of 25 m / s. Only a small number of candidates made an error in their calculation.

Question 2

(a) Most candidates identified the time for one complete oscillation as 0.83 s. Common errors were stating that the time was 83 s or 0.0083 s. Weaker candidates simply copied the digits on the stopwatch to give an answer of 0:00:83 s.

(b) Candidates found this question challenging. A large number of candidates divided 15 by 11.7 to give an answer of 1.28 s rather than the correct answer of 0.78 s. With calculations, candidates should be advised to do a sense check on the size of the anticipated answer, i.e. in this example they would realise that if there are more oscillations than there are seconds, each oscillation takes less than 1 s.

(c) Many candidates found a suitable way of stating (or drawing) that the pendulum swings from P to Q and then back to P. Some thought that an oscillation was from P to Q. Others did not read the question fully and described the motion until the bob stopped swinging (i.e. many oscillations). Others gave answers such as "bob moves from P to Q then back to P then to R".

Question 3

(a) The vast majority of candidates determined the weight correctly as 390 N or 392 N. However, some candidates thought $m = Wg$. Other candidates multiplied the mass by 10. Some divided 40 kg by 10 or 9.8, using $m = Wg$.

(b) Many candidates found this question challenging. Many multiplied 360 by 1.6. Some thought that **(a)** was relevant, and some used g in their calculations. Some candidates separately wrote out the clockwise and anticlockwise moments but made mistakes in equating them, and did not state that they were equal, limiting the credit that could be awarded. However, many candidates correctly calculated the weight as 270 N. Centres are advised to encourage candidates to practise using the principle of moments and to apply the principle of moments to situations with one force each side of the pivot, including balancing of a beam.

Question 4

(a) (i) Most candidates were able to recall that work done = force × distance moved (in the direction of the force) and used this to determine the work done by the electric motor as 12 J. The most common error was to use an incorrect rearrangement of the equation, such as $W = F \div d$, to give an answer of 18.75 J.

(ii) Most candidates scored partial credit, with stronger candidates scoring full credit. Most identified a form of waste energy but few gave an explanation of where this wastage occurred. Incorrect answers such as "as GPE when the motor lifts the load" suggested that candidates would benefit from learning about useful vs wasted energy.

(b) There were several good points to be made about how a hydroelectric power station generates electricity and many candidates gave strong coherent accounts. However, it appeared that many candidates had a detailed knowledge of one renewable means of generating electricity and one non-renewable method. So, in this question there were references to wind generation, wave generation, tidal, geothermal and even solar cells being the energy source. There were some candidates who described the water being heated to form steam that was used to drive the generator. There were many candidates who demonstrated some knowledge but who needed to organise their thinking.

In addition, some misconceptions were evident including, for example, turbines turning motors, water flowing through generators, and water being turned into electricity. A few candidates could not remember the term ‘turbine’ and used words like ‘wheel’, ‘mill’, ‘fan’ or ‘propeller’.

The point that was missed most regularly was that the turbine turns the generator to generate electrical energy. Many candidates believed that it is the turbine that generates electricity.

Question 5

(a) Most candidates knew that the dull black coated container would have the greater temperature rise. However, there were some vague statements seen such as “the dull black container gains more heat”. Most candidates correctly explained this higher temperature in terms of different rates of absorption of thermal energy by the differing surfaces. A common error was to state that the difference was due to different rates of conduction of thermal energy.

(b) Many candidates gained credit for using their knowledge and understanding of thermal conductivity experiments to describe methods that were practical and to state how the order of thermal conductivity would be established. However, some candidates tried to list the materials in order of thermal conductivity.

Question 6

(a) (i) A large number of candidates correctly stated that the dashed line was the normal. However, a variety of incorrect answers were also seen, such as ‘mirror line’, ‘refraction’ or ‘reflection’.

(ii) A large number of candidates correctly identified the angle of incidence but again this was not always well understood.

(iii) Many candidates showed the correct refraction of the ray as it left the glass block. Common errors included drawing the ray refracted towards the normal or drawing the ray going straight on after exiting the glass block. A significant number of candidates did not answer this question.

(b) (i) Many candidates lacked a clear understanding of what is meant by ‘focal length’. Some candidates gave a correct answer of 20 cm but almost every possible combination of distances was seen in other answers. The most common incorrect values were 36 cm and 56 cm.

(ii) Many candidates successfully chose two correct characteristics, and all three possible answers were seen. Some candidates gave one or two incorrect answers, and sometimes contradictions were seen. The most common contradiction was to say ‘real’ and ‘virtual’.

Question 7

(a) (i) The correct answer of 0.8 cm was by far the most common answer. A few candidates gave 1.6 cm.

(ii) Candidates found this question challenging. Many candidates thought that they had to use the wave equation and so tried this but with no success. Most candidates did not realise that they were trying to find out how many waves occurred in 1 second. The most straightforward way of finding this was to look at the graph and count.

(b) (i) The vast majority of candidates correctly identified infrared radiation and ultraviolet radiation, but a number of candidates found this challenging. Centres should encourage candidates to use a mnemonic to recall the order of the main parts of the electromagnetic spectrum and to practise writing down the names as the spelling of these two was often inaccurate.

(ii) Many candidates gave a correct substitution into a correct rearrangement of the wave equation. Stronger candidates were then able to calculate a correct answer. The most common error was to use an incorrect rearrangement of the wave equation such as frequency = wavelength ÷ speed.

Question 8

(a) Most candidates correctly determined the effective resistance of the series combination as 24 Ω. A common error was to multiply the two resistances to give an answer of 128 Ω or to attempt to determine the effective resistance of a parallel combination of resistors.

(b) The majority of candidates correctly evaluated the current in the circuit as 0.25 A. The most common mistake was to use an incorrect rearrangement of $V = I \times R$. Sometimes, candidates substituted the wrong values, i.e. they had $I = V \div R$ and then wrote down $I = 8 \div 2$.

(c) Most candidates correctly identified electrons as the particles moving through metal wires. However, this was not well understood, as many answers of 'electricity', 'charge' and 'protons' were seen.

(d) Many candidates found this question challenging with only stronger candidates correctly drawing a voltmeter symbol in parallel with the 16 Ω resistor. Common errors included drawing an ammeter symbol or just a circle with the word 'meter' and often these were drawn in series with the resistors. There were many candidates who did not attempt this question or who redrew the circuit diagram.

Question 9

(a) Candidates found this question challenging but many correctly determined the current in the router as 0.75 A. A common error was to try and use $V = I \times R$ rather than using $P = I \times V$. Many candidates then incorrectly calculated P as 12 ÷ 9 or 1.25 W. Centres are advised to ensure that candidates can recall and rearrange equations for electric circuits. They should also encourage candidates to study the information provided in a question and to practise selecting the correct equation.

(b) Many candidates scored full credit, but the majority did not multiply the three terms. They often only multiplied 2 terms, and a common incorrect answer was 1200 from 50 × 24 or 0.045 from 0.0090 × 50.

(c) The majority of candidates scored full credit for calculating the number of turns on the secondary coil as 180. Many candidates scored partial credit for correctly substituting into a correct form of the equation. The most common error was using an incorrect rearrangement of the transformer equation. Many candidates thought that $N_s \times V_p = N_p \times V_s$ is a correct form of the transformer equation.

(d) Many candidates scored at least partial credit for this question with clear explanations of how a fuse works. The most common errors were to use 'voltage' or 'electricity' instead of 'current'. Many candidates did not understand how a fuse works, with explanations including, for example, regulating the voltage, regulating the current or diverting excess voltage (or current) to earth. A significant number of candidates stated that it was to protect the router and did not go on to explain how the fuse worked which was what the question asked.

Question 10

(a) (i) Generally, candidates' knowledge of what is meant by nucleons was not secure. Many candidates gained credit but almost every possible pairing of nuclides was seen. Some candidates only gave one nuclide as their answer. Candidates would benefit from practice in determining the numbers of sub-atomic particles in different isotopes of nuclides.

(ii) A poor understanding of how to use nuclide notation was evident here. Many candidates correctly identified Pu-241 as having the most neutrons with 147, but more thought it was Am-241 because 241 + 95 was the biggest number.

(b) Many candidates found this question challenging, with only the strongest correctly determining that after 42 years the amount of plutonium-241 remaining was 9.0 mg. In many cases, the number of half-lives was calculated by dividing 42 by 14 to give 3 half-lives, but very few candidates could use this piece of information successfully. 41 was frequently halved three times, 72 was divided by 3, and some candidates halved the mass two times to get 18 and then halved this to get an answer of 6.

Question 11

(a) (i) Most candidates correctly identified the force keeping planets in orbit around the Sun as the force of gravity. Common errors included gravitational potential energy or just ‘attraction’.

(ii) Almost all candidates correctly identified the galaxy containing our Solar System as the Milky Way galaxy.

(b) Stronger candidates gave a correct meaning of the term light-year. Common errors included stating that it was a speed or a time or even that it was a year with above average amounts of sunlight.

(c) Many candidates found this question challenging. A large number mentioned ‘redshift’ but did not link the redshift to a type of electromagnetic radiation. Some candidates talked about the redshift of stars or the redshift of planets. Very few could link together the different pieces of evidence to give the expected answer.

PHYSICS

Paper 0625/32
Theory (Core)

Key messages

Candidates would benefit from experience of practical or online experiments (particularly thermal physics experiments) in which they practise using scientific key words and drawing links between concepts and physical contexts.

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

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

General comments

Some areas of the syllabus were better known than others. In particular, the following topics were not well understood: energy stores, the kinetic particle model of matter, the transfer of thermal energy (particularly convection and radiation), radioactivity and aspects of the Universe.

For many candidates, the non-numerical questions were more challenging than the numerical questions. A noticeable number of 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.

Many candidates showed full working and gave a formula first, then substituted the given values before working out the answer, which is good practice.

Comments on specific questions

Question 1

(a) (i) Many candidates wrote correctly that the line, or graph, for X was steeper. Such references to the slope were the most direct approach to this question. Other correct answers were based on the idea of a greater increase in speed in the same time interval rather than just a higher speed.

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

(iii) Candidates often recalled the equation to give distance = time × speed and so gained partial credit. The recognition that the distance correlated to the area under the speed–time graph was less secure.

(b) (i) There were many correct answers for force *C*, but some confusion between force and energy was seen, such as the incorrect answer ‘gravitational potential energy’. Answers for force *D* tended to be too vague, e.g. ‘backwards force’ or ‘stopping force’.

(ii) Candidates needed to recognise that as the car was decelerating, the resultant force would act in a backwards direction. Consequently, force *B* would be less than force *D*. Many gave the incorrect answer of 2800 N for force *B*. This would give a resultant force of zero meaning the car would travel at a constant speed.

Question 2

(a) Many correct answers were seen here. A few candidates used the incorrect value of 10 m / s^2 for *g* (acceleration of free fall) instead of the value 9.8 m / s^2 as stated on the cover of the question paper. The strongest candidates started by recalling and writing the equation in symbols, which helped them in making the rearrangement.

(b) The unit of work was well known but the equation for work was more confused. Many incorrect equations were seen, e.g. work = mass ÷ volume, work = mass × distance or work = force ÷ distance. Another common error was substituting the value for mass instead of weight into a correct equation.

(c) Some candidates needed to read the question more carefully as they focused their answer on the lifting of the hammer before it fell onto the metal rod. Only a minority clearly described the transfer between GPE and KE.

Question 3

(a) There were many successful answers which usually started with a statement of the principle of moments, and so set the method up for a correct calculation. A noticeable number of candidates, having successfully calculated a value for the weight of 3.1428…N, gave a final incorrect answer of 3.2 N or 3.5 N instead of the correct answer, to 2 significant figures, of 3.1 N. Weaker candidates attempted to use the $W = mg$ equation, which was not applicable to this situation.

(b) Many correct answers were seen. Common errors were recalling the pressure equation incorrectly, usually pressure = force × area, or miscalculating the area of the block.

Question 4

A significant number of candidates did not answer parts of this question, particularly **(b)(ii)**.

(a) (i) The majority of the candidates correctly described the motion as random. Some confused the separation of particles with the movement of particles and gave the answer ‘far apart’.

(ii) Many knew that the forces are (relatively) weak.

(iii) This was answered well, with most candidates writing about particles colliding with the walls or each other.

(iv) The majority of candidates gave the correct answer.

(b) (i)(ii) Candidates generally lacked knowledge of this section of the kinetic particle model of matter. Common incorrect answers were, for **(i)**: zero, and for **(ii)**: freezing point or Kelvin.

Question 5

(a) Most candidates 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.

(b) (i) Many correct answers were seen here. Some confusion between the terms refraction, diffraction and rarefaction was evident, so more practice in using and defining similar terms would have benefitted candidates. In addition, candidates needed to write clearly because when the answer is just one word, handwritten answers such as reflection, refraction and the confused reflaction were often unclear.

(ii) Many candidates only showed dispersion as the light left the prism. Fewer drew the dispersion occurring as the light entered the prism. The angle of the screen may have given a hint about where the rays should end up. Most candidates were able to label the red and violet/purple rays correctly.

Question 6

(a) (i) The majority of candidates wrote about dull black surfaces being good absorbers, but only those candidates who had read the question carefully realised that this situation was about dull black surfaces being good emitters.

(ii) Only stronger candidates recognised that the temperature must be above room temperature but below 24 °C.

(b) Most candidates recognised the equipment and gained partial credit for recalling standard procedures. Generally, candidates were unfamiliar with this demonstration/experiment. A description of the crystals dissolving in warm water was common.

Question 7

(a) Most candidates correctly gave one tick per line and knew that sound is longitudinal and that microwaves are electromagnetic waves. Knowledge of the other properties was less secure.

(b) The majority of candidates used the equation relating distance, speed and time correctly. Only a few noticed that the distance calculated was twice the Earth–Moon distance and needed to be halved.

(c) (i) Many correct answers were seen, particularly ‘detecting fake bank notes’ and ‘sterilising water’. Some answers were too vague, e.g. ‘checking money’ or uses of other electromagnetic waves, such as TV remotes. A noticeable number of candidates did not give an answer.

(ii) Again, many correct answers were seen, particularly eye or skin damage and skin cancer. Some answers were too vague, such as unqualified ‘cancer’ or ‘damaging health’.

Question 8

(a) Many candidates realised that the question related to operating an electrical appliance in damp conditions. Therefore, correct answers referred either to the risk of electric shock or to the use of the cord as an insulator. Non-scientific reasons, e.g. ‘it was less far to reach’, did not gain credit.

(b) Candidates generally lacked the knowledge of these circuit diagram symbols and few correct answers were seen.

(c) Many successful answers were seen. Answers usually started with the formula in symbols, which set up the method for a correct calculation. There was noticeable confusion between the equations $V = I \times R$ and $P = I \times V$.

Question 9

(a) The majority of candidates displayed a good understanding of resistors in series.

(b) (i) Many candidates were able to recall the correct equation but applying the equation to this situation was less successful. Candidates would benefit from practice in applying $V = I \times R$ to a range of simple circuits.

(ii) A considerable number of candidates did not answer this question. The symbol for a voltmeter was usually seen when the question was answered but connecting the meter in a parallel position was more of a challenge.

(c) A few candidates realised that the combined resistance of resistors in parallel would be less than either of the individual values and made correct suggestions. Although not a requirement in the Core section of the syllabus, a noticeable number of candidates calculated the correct value for the combined resistance of two resistors in parallel.

Question 10

(a) (i)(ii) A good understanding of the nuclear notation for isotopes was seen.

(b) Credit was gained by a large number of candidates for recognising that the decay would span three half-lives. The subsequent calculation to determine the half-life in days was more of a challenge. A number of candidates did not answer this question.

(c) A number of candidates suggested correct sources of background radiation, particularly rocks, buildings and cosmic rays. Some misunderstood the question and wrote the names of elements or particles such as uranium, radon, alpha (α) particles or beta (β) particles. A number of candidates did not answer this question.

Question 11

Many candidates did not give responses to parts of this question, particularly **(c)(i)**.

(a) Most candidates knew the order of planets and completed the diagram correctly. There were many incorrect spellings of the planet names. Although unambiguous spelling errors were given credit, candidates could be encouraged to learn the spellings of, as well as the order of, the planets.

(b) (i) Answers for this part, when seen, were usually correct.

(ii) Some correct answers were seen but a common incorrect answer was microwaves. Candidates could be reminded that if a question, such as this part, asks for one answer, they should only give one answer. If more than one answer is given and one of the answers is incorrect, no credit can be scored.

(c) (i) Few candidates knew that redshift is evidence of the Universe expanding.

(ii) Most candidates knew that gravity is the force involved in planet formation. Many knew that gases accumulate with dust and a minority knew the term ‘accretion disc’.

PHYSICS

Paper 0625/33
Theory (Core)

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(c) (i) Few candidates knew that redshift is evidence of the Universe expanding.

(ii) Most candidates knew that gravity is the force involved in planet formation. Many knew that gases accumulate with dust and a minority knew the term 'accretion disc'.

PHYSICS

Paper 0625/41
Theory (Extended)

Key messages

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

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

Handwriting must be legible. If an answer is changed, it should be crossed out and the new answer written in a blank space. An answer should never overwrite another answer.

Candidates should take note of the command word used in a question. 'Describe' requires an answer in the context of the specific question. 'Explain' requires candidates to apply their knowledge of physics to something specific.

When including a diagram in an answer, it should always be labelled.

General comments

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

In calculation questions, most candidates showed their working clearly and usually included the unit with their answer. Candidates would have benefited from writing down an equation before substituting in numbers and should always include the unit in their answer. This was relevant in **Question 1(b)(iii)**, **Question 3(b)(i)**, **Question 5(c)(ii)**, **Question 7(b)(i)** and **(ii)** and **Question 8(c)(ii)**.

Extracting information from graphs proved challenging for many candidates. They would have benefited from practice in reading graph scales in a variety of contexts. This was relevant in **Question 1(b)(i)** and **(iii)** and **Question 9(b)(i)**.

When a question asks candidates to show that a quantity has a particular value it is important to write out the relevant equation in words or symbols before substituting numbers into the equation. This was done well in **Question 4(b)(i)** and less well in **Question 5(b)(i)**. Manipulating numbers alone did not show understanding of the underlying physics.

Candidates would have benefited from practice in using and converting prefixes in units. This was important in **Question 4(b)(i)**, **Question 5(c)(ii)** and **Question 7(b)(ii).**

Candidates should be able to define basic physics concepts in clear, precise sentences or using equations as appropriate. This was relevant in **Question 3(b)(ii)**, **Question 5(a)**, **Question 5(c)(i)** and **Question 10(b)(i)**.

Comments on specific questions

Question 1

(a) Many candidates correctly identified the two vector quantities in the list: acceleration and velocity. Some candidates only circled one of the vectors. A common error was to identify speed as a vector.

(b) (i) The vast majority of candidates correctly read the maximum speed from the graph. Some candidates omitted the unit from their answer.

(ii) Many candidates described the motion of the train correctly using scientific terms such as acceleration, deceleration and speed. Stronger candidates gave the extra detail that the acceleration and deceleration are constant. Weaker candidates sometimes gave a contradictory response as part of their description. A few candidates described the train as stationary between t = 80 s and 480 s. Some candidates described the constant speed as terminal velocity, a term not relevant in this context, since the motion was horizontal rather than vertical free fall.

(iii) Most candidates recognised that the distance travelled could be calculated by finding the area under the speed–time graph. Candidates who showed clear working and the formulae used were able to gain partial credit when they struggled to determine time segments correctly. Weaker candidates attempted to use $s = vt$ instead of the area under the graph.

(iv) The strongest answers here gave a specific and detailed change, such as “a smaller initial acceleration” or “lower maximum speed”. Some candidates suggested possible causes of the change in motion instead of answering the question.

Question 2

(a) (i) Many candidates identified the two changes to the motion of the object; direction and speed (or magnitude of velocity). Some candidates gained only partial credit by using two different words to express the same change in the motion.

(ii) This question focused on the effect of forces (other than changes in motion) on stationary objects. The reference to one other way forces affect objects should have alerted candidates that answers relating to motion were not relevant here. Only stronger candidates recalled that forces affect the size and shape of objects. Either answer gained credit.

(b) Many candidates illustrated the principle of equilibrium using well-drawn, labelled diagrams. Stronger candidates described the experimental technique, e.g. “position the masses either side of the pivot and move them until the ruler is balanced”. Some candidates were able to gain credit for identifying that (the sum of) the clockwise moments = (the sum of) the anticlockwise moments. Candidates should be aware of the key term ‘perpendicular’ when they refer to the moment of a force.

Question 3

(a) Candidates demonstrated good understanding of the transfer from the gravitational store to the kinetic store and then back again. Some candidates gave incomplete descriptions, stopping at point B. A few candidates noted that there is also an energy transfer to the thermal/internal store. Only the strongest candidates gave a coherent description of all the energy transfers.

(b) (i) Many candidates used $W = Fd$ and $F = mg$ to calculate the work done on the skateboarder and included the unit J or N m with their final answer for full credit. Some candidates recalled the correct formula and then incorrectly substituted the mass as the value for the force in their equation. The weakest candidates were unable to recall the correct formula, usually multiplying mass and distance. The unit was sometimes omitted here and occasionally an incorrect unit was given, such as N.

(ii) A fully correct answer here required an equation with F as the subject and the terms explained. Only the strongest candidates answered fully correctly. Many candidates recalled $F = ma$ which was insufficient without the additional explanation that acceleration = rate of change in velocity.

Question 4

(a) (i) Almost all candidates correctly stated that the main method of thermal energy transfer through air is convection. Any additional response here was a contradiction to the correct answer.

(ii) Stronger answers to this question referred to the bulk properties of hot and cold air and gave a coherent description of the convection current that is set up. Weaker candidates gave confused answers in terms of particles and sometimes referred to particle density changing which is incorrect. Some contradictory statements about the density of hot and cold air were seen. A few answers describing air pressure in terms of particles suggested that some candidates had not understood the question.

(b) (i) The majority of candidates recalled $P = IV$ in words or symbols and converted kilowatts to watts to show that the current in the heater is approximately 8.7 A. A few candidates only gave an equation in numbers which was insufficient to demonstrate an understanding of the physics involved. Some weaker candidates did not convert the power to watts.

(ii) Most candidates chose the 10 A fuse. Full credit here required a statement giving one reason why this was a good choice for the fuse. Many candidates gave a very full answer, explaining why each of the other fuses was unsuitable or stating clearly that 10 A is most suitable since it is slightly higher than the normal operating current. Weaker answers either demonstrated misconceptions in how fuses work or gave unclear explanations.

Question 5

(a) The strongest candidates defined the refractive index in terms of the ratio of the speed of light in two different media. Weaker candidates were sometimes unclear about whether they meant the speed of light in a medium or the speed of the medium. Some candidates recalled the equation $n = \sin i \div \sin r$ here suggesting that they had not read the question carefully.

(b) (i) The clearest answers stated the equation for refractive index in words or symbols and calculated the angle of incidence $i = 60°$. Many candidates only gave the equation in numbers. They also inserted 60 without explaining what this value referred to. Weaker candidates tried to manipulate their equation with an incorrect angle to make it give the stated value.

(ii) Candidates who drew the normal to the incident ray at the point it meets the soap film usually went on to identify the angle of refraction correctly and gained full credit. A few candidates drew the normal and then identified an incorrect angle. Weaker candidates often tried to identify the angle of refraction without drawing the normal. Almost all candidates who attempted this question showed refraction towards the normal in the soap film.

(c) (i) Many candidates stated clearly that monochromatic light is light of a single frequency (or wavelength). Weaker candidates often gave the insufficient answer that it is light of a single colour.

(ii) A fully correct answer here required recall and use of $v = f\lambda$, recall of the speed of light in a vacuum, conversion of nanometres to metres and then the addition of the unit Hz to the answer. The strongest candidates managed all of this. Most candidates were able to recall the equation and the speed of light. Many candidates were unable to convert the wavelength correctly. A few candidates tried to use the wrong equation here, usually $f = 1 \div t$.

Question 6

(a) The strongest candidates stated clearly that magnetic materials experience an attractive force in the presence of a magnet. Many candidates confused magnetic materials with magnets. Some candidates had the misconception that magnetism is related to delocalised electrons.

(b) Candidates who realised that this application required a permanent magnet usually selected steel as an appropriate material for the magnet and gained credit. Many candidates suggested a magnet made of iron because it is easy to magnetise which suggested a misunderstanding of the application. A few candidates selected steel for the magnet and gave the insufficient explanation that this is because steel is strong.

(c) The majority of candidates showed a good understanding that magnetic field lines go from a north pole to a south pole. A few candidates included contradictory answers on the diagram.

(d) The strongest answers clearly explained that the field is stronger when the lines are closer together (or vice versa). Some candidates stated that spacing between field lines affects strength of field without stating the effect. Weaker candidates gave insufficient statements about the more field lines indicating greater strength rather than relating greater strength to a higher density of field lines. A few candidates tried to answer this question in terms of the proximity of field lines to the poles of the magnet rather than proximity to other field lines.

Question 7

(a) (i) Most candidates who correctly identified the characteristics of a diode from the graph were also able to recall its name and gained full credit. Many candidates had difficulty interpreting data from the graph. Some candidates suggested that it showed current is proportional to voltage. Other candidates incorrectly stated that voltage was zero when current was negative.

(ii) The majority of candidates who had identified a diode were able to draw the correct symbol for the component. Common errors were to confuse a diode with a NOT gate or to omit one or both connectors at the ends of the symbol.

(b) (i) Many candidates gave a fully correct answer here including the unit. A few candidates omitted the unit or rounded their answer to one significant figure. Only the very weakest candidates were unable to recall and use $V = IR$ correctly.

(ii) A fully correct answer here involved recall of $E = IVt$ and a conversion of time from minutes to seconds. Some candidates showed their working in stages, using $P = IV$ and then $E = Pt$. A few candidates gained partial credit for an energy calculated without the time conversion. Some candidates incorrectly used the equation $Q = It$ here.

(iii) Stronger candidates realised that with switches S_1 and S_2 closed each heater would have a current of 3.9 A in it. Finding the total current was then a simple sum of the current in each branch. Other candidates still arrived at the correct answer, by making use of the formula for total resistance of two resistors in parallel. A common error by weaker candidates was to assume that the current is still 3.9 A and that this must now be shared by each heater.

Question 8

(a) (i) Some candidates correctly identified both components. Where candidates identified one component correctly it was usually the brushes. Common errors in identifying the slip rings involved confusion between a generator and a motor and calling B either split rings or a commutator.

(ii) To gain credit here, candidates needed to realise that without the soft-iron core there is still a magnetic field between the magnets and so there is still an e.m.f. induced in the generator. Therefore, a correct answer focused on the difference that the soft iron makes. This can be expressed as strengthening the magnetic field or describing the increased output of the generator in terms of electromotive force, current, energy or power.

(b) A fully correct answer here had three components: a sine wave shape, exactly two cycles in 1.00 s and a maximum or minimum value at the start. Most candidates drew a reasonable sine wave, and many illustrated the correct frequency. Only the strongest candidates recognised where in the cycle the generator starts. Candidates are not expected to draw perfect waves under exam conditions. They can improve their drawing by identifying, for example, where the curve will cut the time axis and where it will be at maximum and minimum values before they start to draw.

(c) (i) Many candidates stated that there is less energy/power loss with high-voltage transmission. Some candidates explained this by stating the power loss equation, $P = I^2R$. Other candidates stated that high-voltage transmission meant a lower current and explained that this allowed cost savings because thinner wires could be used. Contradictory statements about resistance or a change in power transmitted were the most common reasons for candidates only gaining partial credit. A few candidates stated that the current is lower, and the power loss is reduced but did not explain either advantage.

(ii) Many candidates correctly recalled and used the equation relating turns ratio to voltage ratio and gained full credit here. Weaker candidates sometimes had difficulty rearranging the equation or deciding which values to substitute for each term in the equation.

Question 9

(a) (i) Only the strongest candidates gained full credit here, recognising that the stable isotope has fewer neutrons because unstable isotopes usually have an excess of neutrons or are too heavy. Many candidates gave an insufficient answer that different isotopes have a different number of neutrons and the same number of protons in the nucleus. Some candidates described radioactive decay of Sr-90 as their explanation. Weaker candidates often gave unclear answers using ‘it’ without being clear about whether ‘it’ was the stable isotope or the Sr-90 isotope.

(ii) There were many fully correct nuclide equations. Where partial credit was gained, it was usually for correctly inserting the proton number and the nucleon number for the beta particle. Some weaker candidates gave yttrium the same atomic number as strontium.

(iii) Most candidates recognised that radiation is harmful to humans. Only the strongest candidates mentioned ionisation in their answer. Many answers suggested that candidates thought the strontium itself was harmful, rather than the beta radiation produced when strontium decays. Statements about radioactivity being harmful were insufficient to gain any credit.

(b) (i) Many candidates gained full credit here, demonstrating confidence in using a decay curve to find the half-life of yttrium. Misreading the time axis led to some candidates gaining only partial credit for otherwise correct methods. Weaker candidates often halved the time rather than the count rate. A few candidates tried to correct the graph for background radiation, not realising that this had already been done.

(ii) Stronger candidates realised that the difference between the table and the graph was the presence or absence of background radiation count rate. Weaker candidates often answered by repeating information provided in the question rather than explaining the difference.

Question 10

(a) The majority of candidates clearly stated the correct composition of Jupiter and the Earth. Some weaker candidates appeared to misunderstand the question and talked about the position of each planet in the order of planets in the Solar System, rather than their composition. A few candidates used language about the life cycle of stars to answer this question.

(b) (i) The clearest answers here were ‘force per unit mass’ or $g = W \div m$. Partial credit was given to candidates who recognised that the gravitational field strength depended on both force and mass. Weaker candidates found it difficult to give a clear definition and many described the field as pulling an object towards the centre of a planet, without any reference to mass.

(ii) Most candidates showed a good understanding of the factors affecting the gravitational field strength on Jupiter and the Earth. A common incorrect answer was the distance of each planet from the Sun.

(c) Many candidates correctly identified the Earth’s faster orbital speed due to its closer proximity to the Sun. Stronger candidates explained that this faster speed is due to the stronger gravitational field closer to the Sun. Some candidates tried to use the equation for average orbital speed to answer this question which often led to them incorrectly stating that Jupiter is faster.

PHYSICS

Paper 0625/42
Theory (Extended)

Key messages

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

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

Handwriting must be legible. If an answer is changed, it should be crossed out and the new answer written in a blank space. An answer should never overwrite another answer.

Candidates should take note of the command word used in a question. 'Describe' requires an answer in the context of the specific question. 'Explain' requires candidates to apply their knowledge of physics to something specific.

When including a diagram in an answer, it should always be labelled. Diagrams should be produced with a sharp pencil, and a ruler where appropriate.

Candidates should ensure they know the values of prefixes, e.g. in GHz.

General comments

Many candidates demonstrated that they had a wide knowledge across the syllabus and there were some very strong responses. The most well-known areas of the syllabus were motion, density, forces, waves and light. Weaker areas were transfer of thermal energy, electricity, radioactivity and some parts of the space physics section.

In calculations, candidates would benefit from stating equations in words or symbols and laying their working out in a logical manner. Candidates should give answers to at least two significant figures and ensure their answer is accompanied by the correct unit(s). Correct conversion of units should also be performed where relevant.

Conversions of units were often not attempted or incorrect in **Question 2(c)(ii)**, **Question 5(b)(iii)**, **Question 7(c)(ii)1** and **2**.

Candidates found it hard to apply knowledge and understanding in specific contexts when giving explanations. This was relevant in **Question 4(a)(i)**, **Question 4(b)**, **Question 9(b)(ii)**, **Question 9(c)(i)** and **(ii)**.

It is important for candidates to focus on understanding rather than relying on recall of learnt facts. They should ensure that their answer is based on the context of the question. Restating the information given in a question is insufficient to gain credit.

Comments on specific questions

Question 1

(a) Most candidates correctly described the motion as constant speed. Weaker candidates gave vague answers of 'constant', 'constant motion', 'no acceleration' or an incorrect answer of 'stationary'.

Candidates should be encouraged to read the axes of the graph carefully to ensure that they are answering the question asked.

(b) The vast majority of candidates correctly calculated the distance travelled between 0 and 3.0 s on the graph by using speed × time or the area under the graph. The most common errors were calculations of the area underneath the whole graph, misreading the speed axis or omitting or giving an incorrect unit.

(c) (i) Most candidates gained credit for simple responses, including 'negative acceleration' and 'speed or velocity decreases'. Other correct descriptions of deceleration were acceptable. Common mistakes included describing decreasing acceleration, providing the definition for acceleration or a vague answer.

(ii) Most candidates drew a tangent on the graph in the correct position. Evaluating the acceleration required candidates to read the coordinates accurately and calculate the gradient, giving an answer to two significant figures, with a correct unit. Common errors included the calculation of 1 ÷ gradient, the use of a single point on the graph or an attempt to use equations to calculate the value of the acceleration. Candidates who drew a large triangle calculated a more accurate value of acceleration.

Question 2

(a) Only stronger candidates correctly defined the moment of a force. There was some confusion between the command words 'define' and 'describe', with weaker candidates often stating that the moment of a force was its turning effect. Another common misconception was that the moment of a force was force × distance, i.e. omitting the word 'perpendicular'.

(b) The strongest candidates correctly identified that the centre of gravity was at the 50 cm point of the metre ruler. Common mistakes were to assume that the metre ruler was balanced at the pivot shown in the diagram or to omit the label showing the value of the distance from the end of the metre ruler. A significant number of candidates did not give an answer to this question.

(c) (i) This question required candidates to apply the principle of moments to equate the sum of the clockwise moments with the anticlockwise moment. The clockwise moment was provided by both the moment due to the 0.12 N force and the weight of the ruler. Candidates who were able to produce a correct equation were usually able to go on to calculate the mass of the ruler by dividing its weight by g. Stronger answers were produced by those candidates who worked logically, line by line, with a clear method, and who correctly labelled all distances on the diagram. Weaker candidates often tried to work backwards from the given value of the mass. This was an unsatisfactory method, and credit was not given for multiplying the mass by g. Some candidates did not give an answer to this question.

(ii) The majority of candidates knew the formula for density. The determination of the volume of the metre ruler was more challenging. The dimensions for the width of the ruler and its thickness were given in metres to assist with this calculation. When the units in calculations were left as kg and m, answers were usually correct and scored full credit. Conversions to other units often led to errors. A common error was to give an incorrect unit for density.

Question 3

(a) Most candidates correctly recalled that momentum is mass × velocity, in symbols or words. Some responses gave the definition of impulse which is a change in momentum and some stated speed instead of velocity. Other incorrect responses stated the principle of conservation of momentum or described moments.

(b) Many candidates answered this question well. Stronger answers stated the formula for the conservation of momentum and followed this with clear, logical working. Many candidates could work out the initial momentum of each train. Some candidates added the initial momentum of each train, not taking account of the opposing direction of the momentum vectors. Candidates should be reminded that both velocity and momentum are vectors and so have a direction. Some candidates did not realise that the masses were combined and/or stated two separate velocities after the collision. There were some significant figure errors and rounding errors. The weakest candidates simply added or subtracted velocities.

(c) Many candidates correctly stated $F = \Delta p \div \Delta t$, correctly substituting in values and stating a correct final answer, with a correct unit. Common errors included multiplying the two numbers given in the question, dividing Δt by Δp, giving an incorrect unit or simply stating that $F = ma$ and not combining this with $a = \Delta v \div \Delta t$.

Question 4

(a) (i) Only the strongest candidates realised that the dull black surface of container A made it a good emitter of infrared radiation or thermal energy. Many candidates correctly chose container A and then explained why by stating that dull black surfaces are good absorbers of radiation. In some cases, candidates had not read the question carefully enough and ignored the word 'change' after 'temperature' and explained a temperature rise. Some weaker candidates referred to the reflection properties of dull black or shiny white surfaces.

(ii) A small minority of candidates recognised that the rate of transfer of energy from the container was equal to the rate of transfer of energy to the container or that there was no net energy transfer. Weaker answers that were insufficient for credit included statements of no energy or simply stated that there was thermal equilibrium.

(iii) Most candidates answered this question correctly. Radiation and conduction were the most frequent incorrect answers.

(b) Most candidates understood the concept of free or delocalised electrons resulting in metals being good conductors of thermal energy. Many stated that metal was a good conductor or that wood was an insulator or a poor conductor. Stronger candidates carefully explained that the delocalised electrons carried (thermal) energy with them. Very few candidates stated that wood only transfers (thermal) energy by lattice vibrations. Some common errors were stating that ions move or referring to an increase of kinetic energy of molecules.

Question 5

(a) Many candidates attempted to describe a suitable method for determining the speed of sound in air. The echo method was used by the majority of candidates. Most candidates also correctly stated that the calculation required the use of $v = s \div t$. Stronger answers stated a suitable distance for the sound to travel, gave a suitable method of producing a short, loud sound, gave details of accurate timing and specified suitable apparatus for measuring time and distance. It was important that candidates stated suitable apparatus for measuring the distance. A metre rule or ruler is unsuitable for measuring a large distance. A significant number of candidates did not give an answer to this question or described the use of $v = f\lambda$ or attempted to use a ripple tank.

(b) (i) The vast majority of candidates answered this question correctly. Incorrect responses included ultraviolet, infrared, ultrasound and electromagnetic.

(ii) Most candidates stated the correct value for the speed of electromagnetic waves in air. Some candidates did not give the unit in their answer. Some candidates stated the value of the speed of sound in air.

(iii) The equation $v = f\lambda$ was well known by most candidates and many were able to correctly rearrange the equation. Fewer candidates were able to convert GHz to Hz. The prefix of 10^9 was not well known.

Question 6

(a) (i) The vast majority of candidates correctly measured the focal length from the centre of the lens and labelled the principal focuses. A common error was to only measure and label one principal focus or mark the focuses on the lens.

(ii) The majority of candidates drew completely correct ray diagrams and these were often very carefully drawn, using a ruler and a sharp pencil. Some candidates refracted the ray at one surface of the lens instead of in the middle. The most common omission was the object or a correct arrow on the object.

(iii) Many candidates used optics terminology correctly. Incorrect responses included virtual, enlarged or diminished.

(b) (i) Stronger answers clearly showed that the rays would not meet until beyond the retina. Many candidates drew converging rays but they met before they reached the retina or on the retina showing confusion between long sight, short sight and the normal eye. Some weaker candidates drew diverging or parallel rays.

(ii) The vast majority of candidates gained credit for a convex lens to correct long-sightedness.

Question 7

(a) Some candidates had clearly learnt this definition and remembered it accurately. Weaker responses did not mention charge, or simply referred to an object, or just stated that a field was force acting on a charge without specifying that it was a region or an area. These answers were insufficient. Incorrect responses included electricity or magnetic fields in the answers.

(b) (i) Most candidates showed a clear understanding of the correct movement of electrons and were awarded full credit. Some candidates contradicted their answer by describing an initial overall charge on the objects, or a movement of ions or positive charges.

(ii) Most candidates demonstrated an understanding that the rods would now repel but fewer candidates went on to state that they would move away from each other. A significant number of candidates did not attempt to answer this question.

(c) (i) Only the strongest candidates correctly stated that 1 kW h is the amount of energy transferred in one hour at the rate of transfer of 1 kW or the amount of energy transferred by an electrical device with a power rating of 1 kW in one hour. Some responses did not include reference to energy transfer and others just described multiplication of power in kW and time in hours.

(ii) 1. Many candidates gained full credit for this question. Most candidates could recall the correct equation. The omission or incorrect conversion of power to kilowatts was the most common reason for only partial credit being awarded.

2. Most candidates used $P = IV$ correctly and gained full credit here. When partial credit was awarded, this was usually due to final answers being provided to only one significant figure, or a rounding error being present. A few candidates attempted to calculate current using the equation $E = VIt$ without the units for energy and time being compatible.

Question 8

(a) (i) Most candidates could correctly identify Q as (carbon) brushes. A significant number of candidates chose split ring or commutator for P and/or Q showing some confusion between a motor and a generator.

(ii) Stronger answers to this question referred to the need for the coil to cut the magnetic field provided by the permanent magnets. Some candidates referred to the cutting of the electromagnetic field, current being cut or secondary coils suggesting confusion with a motor or transformer. A significant number of candidates did not answer this question.

(iii) Most candidates gave a correct answer to this question, usually suggesting more turns on the coil or faster rotation of the coil. The most common incorrect answer was to increase the current, again suggesting confusion with a motor. Some candidates stated what needed changing but did not explicitly state that an increase was required.

(b) (i) Two key points allowed candidates to identify the current in resistor B. Firstly that the p.d. is the same across each branch in the circuit and that total resistance in the second branch is equal to the sum of the resistors B and C. The strongest candidates used this information to explain a correct answer of 1.2 A. Some candidates did not include the unit. Common misconceptions were that the current was split between resistors or that the current was the same in all branches of the circuit.

(ii) Only stronger candidates gained credit here for realising that the current I was the sum of the currents in all the branches. Some candidates gained credit from an error carried forward by adding their value from **(i)** to 4.8 A. A common error was multiplying their answer to **(i)** by 4.

(iii) Almost all candidates correctly stated the equation $V = IR$. Most candidates substituted the correct numbers in the equation, calculated the resistance and gave the correct unit. Weaker candidates used an incorrect value for the current or rearranged the equation incorrectly.

Question 9

(a) (i) Stronger candidates gave a concise, accurate definition of background radiation. Many weaker candidates confused background radiation with half-life, repeated the words from the question or gave vague answers about radiation not from a radioactive source. A significant number of candidates did not answer this question.

(ii) Many candidates correctly stated one of the significant sources contributing to background radiation. Answers that referred to less significant amounts of background radiation or the Sun were too vague. Some candidates confused background radiation with cosmic microwave background radiation (CMBR). Some candidates did not answer this question.

(b) (i) Most candidates correctly completed the nuclide equation for the decay of Ra-223 and gained full credit. Weaker candidates were often unable to recall the proton and nucleon number for the alpha particle. Some candidates added the proton or nucleon number of the alpha particle instead of subtracting them and others made an arithmetical error.

(ii) Many candidates understood that the question was concerned with the low penetration of alpha particles from the source, but many answered too vaguely for credit. The 'explain' command word required candidates to relate this property to the context provided. Relatively few responses stated that alpha would not penetrate the skin from outside of the body. A significant number of candidates did not answer this question.

(c) (i) Candidates needed to relate the penetrating power of gamma radiation to the context of the question here explaining that gamma radiation could penetrate through the body (and hence leave the body). A reference to gamma radiation entering the body did not answer the question.

(ii) Only the strongest candidates were able to explain that the amount of radiation emitted by the source would rapidly reduce because of its short half-life. Vague answers of being less harmful or the source remaining in the body for a shorter time were insufficient. A significant number of candidates did not answer this question.

Question 10

(a) (i) This question was answered well with most candidates correctly identifying planet B and many also stating that it was the planet with the highest temperature.

(ii) Many candidates correctly converted the temperature from K to °C, showing that they knew that absolute zero is –273 °C. Common errors amongst those who recalled 273 were subtracting 93 from 273 to give 180, adding 93 to 273 to give 366, misreading the surface temperature of planet D as –93 and then subtracting 273 to give –366 or misreading planet D as planet B and so subtracting 273 from 623 to give 350.

(iii) Most candidates gained at least partial credit, correctly interpreting the data provided in the table to identify planet A as the planet that an object would fall fastest on. Candidates' explanations for this needed to relate the increased gravitational field strength to an increase in the force or acceleration of the object. Stronger candidates usually gave good explanations.

(b) (i) The most well-known object in the life cycle of a massive star was the black hole. Most candidates gained at least partial credit with the least well answered part being that relating to what the nebula contains. The most common errors included red giant instead red supergiant, not knowing that the nebula contains the heavier elements or white dwarf and black dwarf instead of neutron star and black hole. Some candidates did not answer all or some parts of this question.

(ii) There were some good answers where candidates identified that the brightness of a supernova could measure the distance between the Earth and the galaxy (or supernova). Many candidates guessed various astronomical concepts, such as ‘light-years’, ‘the Hubble constant’, ‘redshift’ etc. Some candidates identified ‘distance’ or ‘distance from Earth’ but these were too vague to gain credit. Candidates should be advised to be specific when describing measurements in physics.

PHYSICS

Paper 0625/43
Theory (Extended)

Key messages

Candidates should always read each question carefully, taking note of the command word, and should ensure they answer the question being asked.

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

When taking numerical data from graphs, candidates should check they have accurately read the graph scales.

General comments

Candidates demonstrated a good understanding across the range of topics in the physics syllabus. Many good answers were seen in questions on motion, electric fields and the Universe. Weaker answers were often seen in questions on momentum, thermal energy transfer, waves and electromagnetism.

Most candidates showed their working in calculation questions and usually included the unit with their answer. Candidates would have benefited from writing down an equation before substituting in numbers and should always include the unit in their answer. This was relevant in **Question 2(b)**, **Question 3(b)(i)**, **Question 4(b)(ii)**, **Question 7(d)**, **Question 9(b)** and **Question 10(c)**.

Candidates should always give an equation in words or symbols when asked to show that a quantity has a particular value. This was important in **Question 2(a)** and **Question 3(a)**.

Candidates should be able to define basic physics concepts in clear, precise sentences or using equations as appropriate. This was relevant in **Question 5(a)**, **Question 6(a)**, **Question 8(a)(i)** and **Question 10(a)**.

Comments on specific questions

Question 1

(a) The majority of candidates correctly read the speed at time = 2.0 s. Some candidates omitted the unit from their answer.

(b) Many candidates recognised that the distance travelled could be calculated by finding the area under the speed–time graph. Weaker candidates attempted to use $s = vt$ instead of the area under the graph.

(c) Stronger candidates read values accurately from the graph and included a unit with their answer. Many candidates recognised that the deceleration could be calculated by finding the gradient of the speed–time graph. As with **(b)**, candidates gained partial credit for clear, correct working.

Question 2

(a) Many candidates recalled $p = mv$ in words or symbols to show that the momentum is approximately 6.55×10^6 kg m / s. Some candidates only gave an equation in numbers which was insufficient to demonstrate an understanding of the physics involved in this question.

(b) Stronger candidates clearly stated the conservation of momentum equation, carefully substituted the correct values into the equation and gave their answer to three significant figures. Weaker candidates calculated the momentum of the nose cone or made a statement of conservation of momentum. A common error was to equate the momentum of the nose cone to momentum of the capsule rather than the space vehicle.

(c) Many candidates recognised that the upward vertical force is equal to the weight and used $m = W \div g$ to calculate the mass of the capsule. Some candidates did not convert kilonewtons to newtons but partial credit was awarded for correct working.

Question 3

(a) The majority of candidates correctly recalled $W = Fd$ in words or symbols. Substituting values of work done and distance into the rearranged equation gained full credit. Weaker candidates gained partial credit for writing the equation only in numerical form or giving the value of the force to three or more significant figures.

(b) (i) Stronger candidates identified that energy transfer is used to calculate the initial speed. Weaker candidates attempted to use a momentum or a force equation rather than kinetic energy.

(ii) Many candidates identified air resistance or drag as a significant factor in lowering the speed of the arrow. Some candidates were able to link this to energy being transferred to the surroundings causing the speed to reduce. Weaker candidates described the speed of the arrow reducing to zero due to hitting the target.

Question 4

(a) Many candidates identified free electrons as important in the process of thermal energy transfer in metals. Stronger candidates were able to explain the role of free electrons in conduction and lattice vibrations. Some candidates described energy transfer from the pan to the water rather than through the copper base.

(b) (i) The majority of candidates correctly defined specific heat capacity. Weaker candidates often stated energy transferred without including per unit temperature change or per unit mass in their answer.

(ii) Most candidates calculated the thermal energy gained by the water. Some candidates realised the energy gained by the water equated to the energy lost by the metal and applied this idea to calculate the specific heat capacity of the metal. Some candidates omitted the unit from their answer.

Question 5

(a) The strongest candidates defined the refractive index in terms of the ratio of the speed of light in two different mediums. Candidates attempting to define refractive index as sine of the angle of incidence divided by sine of the angle of refraction often gave an incomplete definition, omitting the term sine or the angle. Weaker candidates attempted to define the refractive index as the density of the medium or the change in angle.

(b) Many candidates drew ray Q refracted away from the normal. Stronger candidates also recognised that ray P would continue straight.

(c) Stronger candidates identified 49° as the critical angle and correctly used this to calculate the refractive index as 1.3. Weaker candidates often calculated cos 49 or subtracted the angle of 49° from 90°. A few candidates incorrectly included a unit with their answer.

(d) Stronger candidates were able to explain why the ray totally internally reflected comparing the angle of incidence and the critical angle. Weaker candidates repeated the statement of totally internally reflected from the question, or stated 'reflects', without explaining why this occurs. Some candidates incorrectly compared the angle of incidence to the refractive index or angle of refraction.

Question 6

(a) Stronger candidates gave a correct definition of ultrasound as a sound with a frequency higher than 20 kHz. Some candidates misunderstood the question and stated the type of wave or stated a use of ultrasound. Weaker candidates stated the frequency was high without reference to 20 kHz.

(b) Only the strongest candidates were able to recall a correct definition of longitudinal waves. Weaker candidates found it difficult to give a clear definition and many did not refer to vibrations.

(c) (i) The clearest answers here included a labelled diagram to show a wave reflecting from an object. Many candidates identified that the ultrasound would reflect. Some candidates were able to describe measuring a relevant time and using this to calculate distance. Weaker candidates drew unclear diagrams without labels or referred only to ultrasound entering the water without reference to reflection or with an incorrect reference to frequency.

(ii) The majority of candidates gave a correct use of ultrasound. Most candidates referred to medical scanning to monitor pregnancies.

Question 7

(a) The majority of candidates extracted the current value from **Fig. 7.1**. Some candidates omitted the unit from their answer.

(b) Many candidates used $V = IR$ to calculate a correct answer. Weaker candidates incorrectly recalled the equation and divided values from the question. The majority of candidates gave a correct unit with their answer.

(c) Stronger candidates were able to show that the p.d. across the 20 Ω resistor is 9 V with a clear subtraction of the p.d. in **(b)** from the e.m.f. shown in **Fig. 7.1**. Some candidates attempted to use $V = IR$ by substituting 9 V rather than showing that the p.d. is equal to 9 V.

(d) The strongest candidates correctly calculated the current I_2 and used this value to calculate I_1 and then the resistance of R, clearly showing their working for each calculation. Many candidates attempted to use the equation for total resistance of two resistors in parallel. Partial credit was awarded for any correct working when the final answer was incorrect.

Question 8

(a) (i) Stronger candidates gave a clear definition of an electric field as the region where an electric charge experiences a force. Weaker candidates referred to the field caused by electricity or current.

(ii) Many candidates drew four radial fields lines with an arrow in the correct direction to gain full credit. It is important that field lines touch the edge of the point charge and do not continue inside the point charge. A few candidates added contradictory arrows to their field lines.

(b) A correct answer here required candidates to recall and use $W = QV$, to convert megajoules to joules and to include the correct unit in their answer. Stronger candidates managed all of this. Many candidates were able to recall the equation and a correct unit for charge. Many candidates were unable to convert the energy correctly.

(c) Many candidates were able to recall and use $I = Q \div t$ to find a correct answer. Weaker candidates recalled the equation incorrectly and divided the values from the question or showed a correct substitution with an incorrect answer.

Question 9

(a) (i) The strongest answers here gave a clear description of the steps in producing an alternating current, linking a changing magnetic field in the primary coil, the transfer of the magnetic field by the iron core and the secondary coil cutting the magnetic field causing an induced e.m.f. in the secondary coil. Many candidates described an e.m.f. being induced or the iron core transferring the magnetic field. Weaker candidates only referred to a magnetic field rather than a changing magnetic field in the primary coil.

(ii) The majority of candidates gave a correct answer. A few candidates omitted the unit from their answer. Weaker candidates did not correctly recall the equation $V_s \div V_p = N_s \div N_p$.

(b) Stronger candidates were able to recall and use $P = I^2R$ and found a correct answer. Some candidates calculated a value for I^2 and incorrectly gave this as their final answer for current.

(c) Many candidates stated an advantage of less power loss or less energy loss. Some candidates recognised that high-voltage transmission can use thinner cables. Weaker candidates gave insufficient statements about efficiency or speed of transmission.

Question 10

(a) Many candidates gave a clear definition of a light-year as the distance travelled by light in one year. Some candidates stated the distance travelled by light without reference to one year. Weaker candidates incorrectly defined a light-year as a measure of time or the distance to the Sun.

(b) Many candidates recalled the value for the speed of light and correctly calculated the distance from the Sun to the Earth. Some candidates omitted the unit from their answer or gave a unit of kilometres when their value was in metres. Weaker candidates did not rearrange $s = d \div t$ correctly.

(c) Most candidates used data from **Fig. 10.1** to calculate a gradient. Some candidates gave a recalled value for the Hubble constant rather than using the best-fit line as stated in the question. The strongest candidates included a correct unit with their answer.

(d) Candidates needed to identify the source of the electromagnetic radiation and the effect of redshift to increase the wavelength. The strongest candidates were able to state these points. Some candidates misunderstood the question and described the movement of galaxies rather than redshift.

Question 11

(a) Stronger answers to this question referred to the time to halve the number of nuclei or the time for the activity to halve. Some candidates referred to the time for the source or mass to reduce by half which was insufficient.

(b) (i) The complete nuclear equation was given by many candidates. Some candidates swapped the proton and nucleon number for the beta particle. A few candidates gave an answer using Pa instead of U for the product. A common error was to give a beta-plus particle rather than a beta-minus particle.

(ii) Stronger candidates were able to recall that a neutron changes into a proton. Some candidates stated that the nucleus gained a proton without referring to losing a neutron which was insufficient.

(c) Many candidates gave one correct reason with the strongest candidates identifying two correct reasons. Some candidates referred to energy rather than kinetic energy, or charge without a comparison which was insufficient.

PHYSICS

Paper 0625/51
Practical Test

Key messages

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

General comments

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

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

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

Questions on experimental techniques were answered much more effectively by candidates who clearly had regular experience of similar practical work and much less successfully by those who, apparently, had not.

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

Comments on specific questions

Question 1

(a) (i) Candidates were expected to indicate measurements above and below the ball (as shown in **Figure 1.1**).

(ii) Many candidates successfully recorded two realistic readings.

(iii) Most candidates correctly calculated the average value.

(b) Most candidates calculated the volume correctly and added the unit cm^3.

(c) These questions were answered well by the majority of candidates. A few candidates did not include working.

(d) Candidates were expected to give the answer to two or three significant figures.

Question 2

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

(b) (i) Many candidates successfully recorded the appropriate units.

(ii) Most candidates recorded decreasing temperatures.

(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 is clear. Most candidates obtained a realistic set of readings that resulted in plots producing a clear curve. However, some candidates drew a straight line that did not match the plots or a series of straight lines joining each plot to the next.

(d) Candidates were expected to suggest using insulation around the beaker and placing a lid on top. Alternative suggestions, e.g. shielding from draughts, were also accepted.

Question 3

(a) Most candidates drew a neat diagram with the normal correctly positioned and the angle of incidence at 40°. Candidates were expected to show a pin separation of at least 5 cm. However, some candidates placed the pins too close to each other. The reflected ray was drawn correctly by many candidates.

(b) The angle α was measured correctly by many candidates, but some measured the angle between the ray and the mirror.

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

(d) Candidates were expected to measure the angle β to within 2°.

(e) 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.

(f) Candidates were expected to suggest two suitable techniques used to obtain a good set of results. Suggestions could include viewing the bases of the pins (or ensuring the pins were vertical), using a sharp pencil (or drawing thin lines), placing the pins as far apart as possible (or more than 5 cm apart), or using thin pins.

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 was required. Candidates needed to concentrate on the readings that needed to be taken and the essentials of the investigation. It may benefit candidates to plan their table of readings before writing the method to help them to think through the measurements that need to 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 (in series with the circuit) and a voltmeter (in parallel with test wire). The test wire needed to be clearly indicated.

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

For the method, candidates needed to measure the wire diameter, current and voltage. The procedure should then have been repeated with different diameters. A vague reference to repeating was not sufficient as it was not clear whether the test variable had been changed. Then the resistance needed to be calculated.

Many candidates drew a suitable table. They were expected to include columns for diameter, voltage, current and resistance each with the appropriate unit.

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

PHYSICS

Paper 0625/52
Practical Test

Key messages

- Candidates need to have a thorough understanding of practical work during the course. They should have as much personal experience of carrying out experiments themselves as possible. The practical work should include reflection and discussion of the significance of results, precautions taken to improve reliability and control of variables.
- Centres are provided with a list of required apparatus well in advance of the examination date. Where centres wish to substitute apparatus, it is essential to contact Cambridge to check that the change is appropriate and that candidates will not be disadvantaged. Any changes must be recorded in the supervisor's report.

General comments

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

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

The majority of candidates were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of the practical test were attempted and there was no evidence of candidates running short of time. Most candidates were able to follow instructions correctly, record observations clearly and perform calculations accurately and correctly. Units were well known and were almost always included. Writing was neat and legible and ideas were expressed logically. However, many candidates seemed less able to reach conclusions backed up by evidence, or to present well thought out conclusions.

The gathering and recording of data presented few problems for any candidates. There was evidence of some candidates not using a calculator. Where calculators are used, it is still helpful if candidates show their working.

The ability to record readings to an appropriate precision, usually reflecting the measuring instrument being used, or to quote a calculated result to an appropriate number of significant places, caused difficulty for many candidates. There were also many examples where candidates repeated a measurement and overwrote their first answer. This often made it difficult for the answer to be read and for credit to be awarded. Candidates should be reminded to cross out completely and to rewrite their answers so that there is no ambiguity. Some candidates had difficulty in choosing an appropriate scale to plot their graphs and in drawing a best-fit line to display their data.

Comments on specific questions

Question 1

(a) Most candidates followed the instruction to measure the height *h* of the water in the test-tube that they had poured into it from the measuring cylinder. The instruction to measure *h* in centimetres to the nearest millimetre was sometimes not followed. A few candidates rounded all values of *h* to the nearest centimetre, or gave values of *h* to 0.01 cm. The reading *R* of the volume of water remaining in the measuring cylinder was usually recorded to the nearest cm^3.

(b) Candidates were required to continue adding water from the measuring cylinder into the test-tube to obtain four more values of *h* and *R*. Most results tables were complete with five values each of *h* and *R* recorded.

(c) The volume *V* of water poured into the test-tube for each different *h* was almost always calculated correctly.

(d) Graph-plotting skills were of a reasonable standard, but many responses did not score full credit. The most common sources of error were:

- awkward scales, such as 3 or 7. Choosing such scales makes the points much harder to plot and more difficult to read
- choosing scales so that the plotted points did not cover at least half of the given grid
- forcing the line of best fit to pass through the origin, resulting in an inappropriate line of best fit.

If candidates consider a reading to be anomalous when plotting the graph and decide to ignore it when drawing the line of best fit, then that data point should be identified as such on the graph, by circling it, for example. However, there were many excellent, carefully drawn, best-fit lines produced.

(e) As expected, candidates who drew a large triangle to determine the gradient of their graphs obtained the most accurate values for the gradient of the line. However, many candidates showed no clear indication on the graph of how the information to determine the gradient had been obtained, despite the instruction being given to do so.

(f) The majority of candidates used the equation supplied to calculate a value for the internal diameter *d* of the test-tube. Most candidates obtained a value for *d* which was within the tolerance allowed, and obtained credit for accuracy for performing the experiment with care. Candidates were also asked to suggest a reason why their calculated value of *d* was only approximate. The majority of candidates chose to discuss the fact that their line of best-fit was approximate, or that the gradient of the graph could vary. Both of these reasons were relevant to the experiment and were credited. Only a few candidates focussed their attention on the actual conduct of the experiment. Creditworthy answers such as “the test-tube is not a perfect cylinder”, “it is difficult to get the ruler close enough to the test-tube to measure *h* accurately”, “water sticks to the side of the measuring cylinder when pouring” were rarely seen.

(g) The majority of candidates understood the importance of avoiding line-of-sight errors when reading scales and were able to describe how such errors can be avoided.

Question 2

(a) Candidates were required to draw a circuit diagram of a circuit set up in advance for them by the supervisor. Most candidates recognised that the circuit was a series circuit and received credit for this. Far fewer drew a circuit which contained all the required components and used the correct symbols for the components, despite a selection of symbols from which to choose being supplied. The most common error was to choose an incorrect symbol for an LDR from the three alternatives provided.

(b) The voltmeter readings V_{XY} and V_{YZ} were nearly always recorded to an appropriate level of precision and the majority of candidates correctly showed that $V_{YZ} > V_{XY}$.

(c) Most candidates followed the instructions and used the given equations to calculate the current in the circuit and the resistance of the LDR in bright light correctly.

(d) The majority of candidates repeated the voltage measurements they had taken in **(b)** to measure V_{XY} and V_{YZ} when the LDR had a piece of card placed over it.

(e) Candidates were asked to observe and comment on the reading on the voltmeter across the LDR as a piece of card was held 50 cm above the LDR and slowly moved towards the LDR until it rested on top of the LDR. Most candidates observed and correctly stated that the voltmeter reading increased as the card was moved closer to the LDR. Only a small minority noticed that as the card moved towards the LDR, the voltmeter reading remained constant until the card got very close to the LDR, and only then did it begin to increase.

(f) Candidates were asked to use the results they had collected in **(b)** and **(d)** to state how the value of (V_{XY} + V_{YZ}) changed when the LDR was covered by the card. This presented no problems to stronger candidates who stated that (V_{XY} + V_{YZ}) did not change. Comments such as "the value remains approximately constant" were also accepted. Many candidates found it difficult to express in words what the numerical values of V_{XY} and V_{YZ} in **(b)** and **(d)** indicated.

(g) Only stronger candidates were able to suggest what caused the voltage V_{YZ} across the LDR to change when the intensity of the light reaching the LDR decreased. The expected answer was that the resistance of the LDR increased. Many candidates merely stated that the resistance increased, which did not gain any credit, because there was also a resistor in series with the LDR.

Question 3

(a) Most candidates followed the instructions and measured the object distance x_1 from the centre of the lens to the illuminated object when a sharp magnified image of the object was formed on the screen. The instruction to measure x_1 in centimetres to the nearest millimetre was sometimes not followed. Candidates were then required to continue to move the lens away from the illuminated object until a sharp, diminished image was formed on the screen. The majority of candidates measured the object distance y_1 from the centre of the lens to the illuminated object and obtained an answer within the tolerance allowed. The value $d = (y_1 – x_1)$ was almost always calculated correctly.

(b) Most candidates substituted the relevant values into the given equation to calculate a value for f_1, the focal length of the lens. Candidates were asked to give their value for f_1 to a suitable number of significant figures for the experiment. Most candidates quoted their values of f_1 to two or three significant figures.

(c) Candidates were required to repeat the procedure they had followed in **(a)** with a different object to screen distance and to obtain a second value f_2 for the focal length of the lens. This was done correctly by most candidates, but some candidates rounded their answers incorrectly.

(d) Candidates were asked to state whether their values of f_1 from **(b)** and f_2 in **(c)** 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. Many candidates were able to do so. The easiest way to show this was to calculate the ratio of the smaller of the two values to the larger. If the value obtained was 0.9 (90%) or greater, then the quantities could be considered to be equal. Another equally acceptable method was to calculate the ratio of the difference between the two values to either of these values. If the answer obtained was 0.1 (10%) or less, then the quantities could be considered to be equal. If both values of f recorded by candidates were equal, it was sufficient to state just that to obtain full credit.

(e) Although most candidates knew of a technique that is used to ensure that the image on the screen is focussed as clearly as possible in a lens experiment, only a few stronger candidates applied a technique suitable for this particular experiment. Very few candidates realised that since the distance between the screen and the illuminated object is fixed for each calculation of f, moving the screen and/or the object was an inappropriate choice. The only acceptable answer here was to move the lens slowly or backwards and forwards. Only the strongest candidates were able to suggest an acceptable reason as to why this experiment is usually done in a darkened room. Acceptable answers were that there is better contrast between the image and the rest of the screen, or that the edges of the image are more visible or easier to view.

Question 4

The general quality of answers was high. The most comprehensive approach for candidates was to address each of the bullet points in the question in the order given in the question.

The additional apparatus needed, as requested in the question, was not always stated. The only other apparatus needed was a thermometer to measure the initial and final temperature of the water and a stopwatch or timer to measure the time of cooling of the hot water.

Credit for method was gained by the majority of candidates. Candidates needed to state that the water was heated to a known or measured temperature, left to cool for five minutes, and the final temperature of the water measured. Then the process is repeated for a different value of the initial hot water temperature.

Despite the fact that the time of cooling of the hot water was specified to be five minutes in the question, many candidates did not take note of this and used a random time of their own choosing. A number of candidates did not follow the brief and measured the time that the hot water took to cool down to room temperature.

The choice of control variable was usually correct, with the majority of candidates choosing the mass or volume of the water or the time of cooling.

Tables were usually well set out with appropriate headings and units given. Candidates should be reminded that the results table headings must contain the physical quantities that need to be actually measured during the experiment. In this particular case, the only quantities that needed to be measured were the initial and final temperatures of the hot water. The rate of cooling of the hot water could then be calculated from these two quantities, together with the fact that the water was cooling for five minutes. Many tables had a column for rate of cooling, but not for the final temperature of the water, which was the actual quantity being measured. Candidates can include extra columns in their tables, as long as columns for the actual quantities that need to be measured are present.

The quality of the conclusions was generally good. However, there were many predictions made, some of which candidates attempted to back up with relevant theory. Predictions from theory cannot gain credit as conclusions, as they state what will or what is expected to happen, rather than how the results can be used to determine what has happened. If the investigation requires a line graph, then this is one of the more straightforward ways of gaining credit for a conclusion, provided that the axes are correctly specified.

Candidates were able to score credit by making one of four additional points in their answers. They could have given a second valid control variable, stated that at least five sets of data should be taken, stated that each measurement should be repeated and an average taken, or shown evidence of having used the rate equation supplied in the question. Candidates should be reminded that statements such as ‘repeat the experiment’ or ‘repeat and average’ are too vague to gain credit unless it is clear that these ‘repeats’ are being carried out for each (or the same) value of the independent variable.

PHYSICS

Paper 0625/53
Practical Test

Key messages

Candidates need to have experience of practical work and of carrying out experiments 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 techniques and explanations need to be based on data with practical, rather than theoretical, considerations being taken.

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

All questions should be read carefully so that candidates have a complete understanding of what is being asked .

Where justification of a statement is needed, it is essential that reference is made to the numerical results calculated.

General comments

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

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

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

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

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

Comments on specific questions

Question 1

(a) (i) Most candidates read the force meters correctly and calculated the weight of the ruler.

(ii) Only stronger candidates gave suitable procedures. Candidates that drew a diagram were more likely to answer this correctly.

(b) Most candidates correctly recorded their values to a consistent number of decimal places. A few had decreasing values indicating that they had used the ruler the wrong way round.

(c) Most candidates understood how to sketch a graph, labelling the axes correctly, with the appropriate quantity and units. Most candidates correctly plotted their points accurately. A few candidates used blobs that were too large. There were many good thin lines plotted. Lines of best fit should have an even distribution of points on either side and candidates should not assume the line will pass through the origin.

(d) Most candidates correctly read their intercept and calculated the weight of the ruler.

(e) Most candidates stated it was easy to choose the line of best fit but very few gave a valid justification.

Question 2

(a) (i) Almost all candidates correctly stated the room temperature with the correct units.

(ii) Most candidates correctly described a technique for a correct reading.

(b) Most candidates correctly recorded the temperature.

(c) Most values were correctly calculated with the correct units and decreasing answers were seen.

(d) (i) Many candidates identified the pattern correctly but fewer made any relevant justification from their results.

(ii) Most candidates realised that the temperature would have returned to, or be close to, room temperature.

(e) (i) Many candidates identified that the cooling rate would be lower but very few gave a valid explanation.

(ii) Most candidates gained credit here with the volume of water or room temperature being the most commonly seen answers.

Question 3

(a) (i) Most candidates correctly read the meters and had decreasing values for current.

(ii) Most candidates correctly calculated the values of resistance.

(b) (c) Most candidates correctly recorded increasing values of resistance, but not all responses were consistent to 2 or 3 significant figures.

(d) (i) Most calculations were correct but not all were within 10 per cent of each other.

(ii) Many candidates made a correct statement but not all gave an appropriate justification.

(e) Few candidates realised that the purpose was to limit the current from becoming too large.

(f) There were many vague answers seen which did not fully answer the question.

Question 4

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

Many candidates did not state that both a protractor and a ruler were needed as extra apparatus.

Many candidates gave an incomplete method, omitting to mention any means of tracing the emerging ray.

Most candidates identified the need to repeat the experiment with different concentrations and to keep the incident ray angle constant. However, many candidates did not label the concentration with the correct units in the table. Most correct analysis was seen from a line graph being stated. Only stronger candidates realised that it was necessary to use at least 5 values of concentration and only the strongest candidates stated that it was necessary to repeat angle readings for each value of density and calculate averages.

Candidates should be reminded that it is good practice to go back and read the given method to see if it is possible to carry out the experiment described.

PHYSICS

Paper 0625/61
Alternative to Practical

Key messages

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

General comments

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

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

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

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

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

Comments on specific questions

Question 1

(a) (i) Many candidates recorded the two correct readings.

(ii) Most candidates correctly calculated the average value.

(iii) Many candidates scored partial credit with a relevant comment about the difficulty of measuring the diameter of a sphere with a ruler. Few identified parallax errors as the cause of the difficulty.

(b) Most candidates calculated the volume correctly and added the unit cm^3.

(c) This question was answered well by the majority of candidates. A few candidates did not include their working.

(d) Candidates were expected to give the answer to two or three significant figures with the unit g/cm^3.

Question 2

(a) Most candidates correctly indicated room temperature.

(b) Many candidates successfully recorded the appropriate units, cm^3 and °C.

(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 is clear. Most candidates obtained a realistic set of readings that resulted in plots producing a clear curve. However, some candidates drew a straight line that did not match the plots or a series of straight lines joining each plot to the next.

(d) (i) Candidates were expected to realise that it is important to add the cold water without delay so that thermal energy loss to the surroundings is minimised.

(ii) Stirring was also required to ensure an even temperature distribution in the beaker.

(e) Candidates were expected to suggest using insulation around the beaker and placing a lid on top. Alternative suggestions, e.g. shielding from draughts, were also accepted.

(f) Most candidates correctly suggested a measuring cylinder.

Question 3

(a) Most candidates drew a neat diagram with the normal correctly positioned and the angle of incidence at 40°. The reflected ray was drawn correctly by many candidates.

(b) Candidates were expected to show a pin separation of at least 5 cm. Some candidates placed the pins too close to each other.

(c) Most candidates drew the line with care. The angle α was measured correctly by many candidates, but some measured the angle between the ray and the mirror.

(d) Candidates were expected to follow the instructions carefully and many did so, resulting in the rays being drawn in the correct quadrants. Candidates were expected to draw the angle at 50° to within 2°.

(e) 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.

(f) Candidates were expected to suggest two suitable techniques used to obtain a good set of results. Suggestions could include viewing the bases of the pins (or ensuring the pins were vertical), using a sharp pencil (or drawing thin lines), placing the pins as far apart as possible (or more than 5 cm apart), or using thin pins.

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 was required. Candidates needed to concentrate on the readings that needed to be taken and the essentials of the investigation. It may benefit candidates to plan their table of readings before writing the method to help them to think through the measurements that need to 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 (in series with the circuit) and a voltmeter (in parallel with test wire). The test wire needed to be clearly indicated.

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

For the method, candidates needed to measure the wire diameter, current and voltage. The procedure should then have been repeated with different diameters. A vague reference to repeating was not sufficient as it was not clear whether the test variable had been changed. Then the resistance needed to be calculated.

Many candidates drew a suitable table. They were expected to include columns for diameter, voltage, current and resistance each with the appropriate unit.

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

PHYSICS

Paper 0625/62
Alternative to Practical

Key messages

- Candidates need to have a thorough understanding of practical work during the course. They should have as much personal experience of carrying out experiments themselves as possible. The practical work should include reflection and discussion of the significance of results, precautions taken to improve reliability and control of variables.
- Candidates should be advised to read the questions through very carefully to ensure that they are answering the question as written, and not simply recalling the answer to a different question.

General comments

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

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

The majority of candidates were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of the practical test were attempted and there was no evidence of candidates running short of time. Most candidates were able to follow instructions correctly, record observations clearly and perform calculations accurately and correctly. Units were well known and were almost always included. Writing was neat and legible and ideas were expressed logically. However, many candidates seemed less able to reach conclusions backed up by evidence, or to present well thought out conclusions.

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

Comments on specific questions

Question 1

(a) Most candidates measured the height h of the water in the test-tube correctly. The instruction to measure h in centimetres to the nearest millimetre was sometimes not followed. The reading R of the volume of water remaining in the measuring cylinder was usually recorded correctly as 89 cm^3. Common incorrect answers were 80.9 cm^3 and 91 cm^3. The volume V of water poured into the test-tube was almost always calculated correctly.

(b) The majority of candidates understood the importance of avoiding line-of-sight errors when reading scales and were able to describe how such errors can be avoided. Most candidates gained credit by drawing a diagram.

(c) Graph-plotting skills were of a reasonable standard, but many responses failed to score full credit. The most common sources of error were:

- awkward scales, such as 3 or 7. Choosing such scales makes the points much harder to plot and more difficult to read
- choosing scales so that the plotted points did not cover at least half of the given grid
- forcing the line of best fit to pass through the origin, resulting in an inappropriate line of best fit.

If candidates consider a reading to be anomalous when plotting the graph and decide to ignore it when drawing the line of best fit, then that data point should be identified as such on the graph, by circling it, for example. However, there were many excellent, carefully drawn, best-fit lines produced.

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

(e) The majority of candidates used the equation supplied to calculate a value for the internal diameter *d* of the test-tube. Most candidates obtained a value for *d* which was within the tolerance allowed and obtained credit for accuracy for performing the experiment with care. Candidates were also asked to suggest a reason why their calculated value of *d* was only approximate. The majority of candidates chose to discuss the fact that their line of best-fit was approximate, or that the gradient of the graph could vary. Both of these reasons were relevant to the experiment and were credited. Only a few candidates focussed their attention on the actual conduct of the experiment. Creditworthy answers such as “the test-tube is not a perfect cylinder”, “it is difficult to get the ruler close enough to the test-tube to measure *h* accurately”, “water sticks to the side of the measuring cylinder when pouring” were rarely seen.

Question 2

(a) Most candidates completed the circuit by adding the correct symbol for an LDR chosen from the list of possible symbols supplied.

(b) The voltmeter needed to measure the potential difference across the 470 Ω resistor was almost always added correctly to the given circuit – in parallel with the resistor. The symbol was usually correct, but sometimes had a line through the circle which was incorrect. The majority of candidates recorded the reading on the voltmeter scale correctly as 0.8 V. A common incorrect answer was 1.2 V.

(c) Most candidates followed the instructions and used the given equation to calculate the current in the circuit correctly. Common errors included rounding a correctly calculated value of the current back to 1 significant figure and omitting to give the unit for current.

(d) Most candidates used the value for V_{YZ} and the given equation to calculate the resistance of the LDR in bright light correctly.

(e) The majority of candidates used the given equation and voltage values supplied to calculate the resistance of the LDR when it had a piece of card placed over it. Candidates were then asked to study a table of results showing how the potential difference across the LDR varied, as a piece of card was placed on the LDR and then raised vertically to a distance of 30 cm above the card. Most candidates observed and correctly stated that the voltmeter reading decreased as the card was moved away from the LDR. Far fewer candidates noticed and stated that as the voltmeter moved away the LDR, the voltmeter reading, after initially decreasing, became constant after the card got further away than 15 cm from the LDR.

(f) Candidates were asked to use their numerical answer to **(b)(ii)** and values supplied in **(d)** and **(e)** to state how the value of (V_{XY} + V_{YZ}) changed when the LDR was covered by the card. This presented no problems to stronger candidates who stated that (V_{XY} + V_{YZ}) did not change/remained constant. Comments such as "the value remains approximately constant" were also accepted. Many candidates found it difficult to express in words what the numerical values of V_{XY} and V_{YZ} in **(b)** and **(e)** indicated.

Question 3

(a) The object distance *x* from the centre of the lens to the illuminated object was measured correctly by the majority of candidates. The instruction to measure *x* in centimetres to the nearest millimetre was sometimes not followed. Most candidates understood what the term 'to a scale of one-fifth full size' meant, and multiplied their value of *x* by five, to obtain the actual object distance *X*. Occasionally *x* was incorrectly divided by five.

(b) Candidates were supplied with a diagram of the illuminated object in the shape of an equilateral triangle and required to draw a diminished, inverted image of it. Most candidates drew a triangle which was inverted, but far fewer made it obvious that the triangular image was diminished. The inverted image drawn was often the same size as the object, or in some cases larger. The value $d = (Y - X)$ was almost always calculated correctly.

(c) Most candidates substituted the relevant values into the given equation to calculate a value for f_1, the focal length of the lens. Candidates were asked to give their value for f_1 to three significant figures and most candidates did this.

(d) Candidates were required to repeat the calculation they had completed in **(c)** with a different object to screen distance and values of *X* and *Y* provided, to obtain a second value f_2 for the focal length of the lens. This was done correctly by most candidates, but some candidates rounded their answers incorrectly.

(e) Candidates were asked to state whether their values of f_1 in **(c)** and f_2 in **(d)** 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. Many candidates were able to do so. The easiest way to show this was to calculate the ratio of the smaller of the two values to the larger. If the value obtained was 0.9 (90%) or greater, then the quantities could be considered to be equal. Another equally acceptable method was to calculate the ratio of the difference between the two values to either of these values. If the answer obtained was 0.1 (10%) or less, them the quantities could be considered to be equal. Other acceptable and novel methods of doing this were also seen and credited. If both values of *f* recorded by candidates were equal, it was sufficient to state just that to obtain full credit.

(f) Although most candidates knew of a technique that is used to ensure that the image on the screen is focussed as clearly as possible in a lens experiment, only a few stronger candidates applied a technique suitable for this particular experiment. Very few candidates realised that in this experiment, since the distance between the screen and the illuminated object is fixed for each calculation of *f*, moving the screen and/or the illuminated object slowly or backwards and forwards to obtain a sharp focus was an inappropriate choice. The only acceptable answer here was to move the lens slowly or backwards and forwards. Only the strongest candidates were able to suggest an acceptable reason as to why this experiment is usually done in a darkened room. Acceptable answers were that there is better contrast between the image and the rest of the screen, or that the edges of the image are more visible or easier to view.

Question 4

The general quality of answers was high. The most comprehensive approach for candidates was to address each of the bullet points in the question in the order given in the question.

The additional apparatus needed, as requested in the question, was not always stated. The only other apparatus needed was a thermometer to measure the initial and final temperature of the water and a stopwatch or timer to measure the time of cooling of the hot water.

Credit for method was gained by the majority of candidates. Candidates needed to state that the water was heated to a known or measured temperature, left to cool for five minutes, and the final temperature of the water measured. Then the process is repeated for a different value of the initial hot water temperature.

Despite the fact that the time of cooling of the hot water was specified to be five minutes in the question, many candidates did not take note of this and used a random time of their own choosing. A number of candidates did not follow the brief, and measured the time that the hot water took to cool down to room temperature.

The choice of control variable was usually correct, with the majority of candidates choosing the mass or volume of the water or the time of cooling.

Tables were usually well set out with appropriate headings and units given. Candidates should be reminded that the results table headings must contain the physical quantities that need to be actually measured during the experiment. In this particular case, the only quantities that needed to be measured were the initial and final temperatures of the hot water. The rate of cooling of the hot water could then be calculated from these two quantities, together with the fact that the water was cooling for five minutes. Many tables had a column for rate of cooling, but not for the final temperature of the water, which was the actual quantity being measured. Candidates can include extra columns in their tables, as long as columns for the actual quantities that need to be measured are present.

The quality of the conclusions was generally good. However, there were many predictions made, some of which candidates attempted to back up with relevant theory. Predictions from theory cannot gain credit as conclusions, as they state what will or what is expected to happen, rather than how the results can be used to determine what has happened. If the investigation requires a line graph, then this is one of the more straightforward ways of gaining credit for a conclusion, provided that the axes are correctly specified.

Candidates were able to score credit by making one of four additional points in their answers. They could have given a second valid control variable, stated that at least five sets of data should be taken, stated that each measurement should be repeated and an average taken, or shown evidence of having used the rate equation supplied in the question. Candidates should be reminded that statements such as ‘repeat the experiment’ or ‘repeat and average’ are too vague to gain credit unless it is clear that these ‘repeats’ are being carried out for each (or the same) value of the independent variable.

PHYSICS

Paper 0625/63
Alternative to Practical

Key messages

Candidates need to have experience of practical work and of carrying out experiments 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 techniques, and explanations need to be based on data with practical, rather than theoretical, considerations being taken.

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

All questions should be read carefully so that candidates have a complete understanding of what is being asked.

Where justification of a statement is needed, it is essential that reference is made to the numerical results calculated.

General comments

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

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

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

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

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

Comments on specific questions

Question 1

(a) Few suitable procedures were seen. Candidates that drew a diagram were more likely to gain credit here.

(b) (i)(ii) Most candidates correctly read both scales.

(c) Most candidates labelled the axes correctly with the appropriate quantity and units. Most candidates correctly plotted their points. A few candidates had plots that were too large with blobs. There were many good thin lines plotted. Lines of best fit should have an even distribution of points on either side and they should not assume the line will pass through the origin.

(d) Most candidates correctly read their intercept and calculated the weight of the ruler.

(e) Most candidates stated it was easy to choose the line of best fit but very few gave a valid justification.

(f) Very few candidates suggested that the force meter had not been zeroed.

Question 2

(a) Most candidates correctly read the thermometer with only very few giving the reading as 20.1 °C.

(b) Most candidates correctly stated that the scale should be read either perpendicularly or at eye level.

(c) Most candidates made a correct estimate.

(d) (i)(ii) Many candidates made correct calculations and included correct units.

(iii) Many candidates gave their answers to 2 or 3 significant figures.

(e) (i) Many candidates identified the pattern correctly but fewer made any relevant justification from their results.

(ii) Most candidates realised that the temperature would have returned to, or be close to, room temperature.

(f) (i) Many candidates identified that the cooling rate would be lower but very few gave any valid explanation.

(ii) Most candidates gained credit here with the volume of water or room temperature being the most commonly seen correct answer.

Question 3

(a) Most candidates correctly attached the voltmeter.

(b) (i) Most candidates correctly read both meters.

(ii) Most candidates correctly calculated the resistance.

(c) (i) Many correct answers were seen but some candidates did not show consistent significant figures.

(ii) Many candidates made a correct statement but not all gave an appropriate justification.

(d) Few candidates realised that the purpose was to limit the current from becoming too large.

(e) (i) There were many incorrect or incomplete symbols seen.

(ii) There were many vague answers seen which did not fully answer the question.

Question 4

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

Many candidates did not state that both a protractor and a ruler were needed as extra apparatus.

Many candidates gave an incomplete method, omitting to mention any means of tracing the emerging ray.

Most candidates identified the need to repeat the experiment with different concentrations and to keep the incident ray angle constant. However, many candidates did not label the concentration with the correct units in the table. Most correct analysis was seen from a line graph being stated. Only stronger candidates realised that it was necessary to use at least 5 values of concentration and only the strongest candidates stated that it was necessary to repeat angle readings for each value of density and calculate averages.

Candidates should be reminded that it is good practice to go back and read the given method to see if it is possible to carry out the experiment described.