PHYSICS

Paper 0625/11
Multiple Choice Core

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

Key messages

A number of candidates found the paper quite challenging.

General comments

Candidates answered **Questions 1**, **3**, **4**, **9** and **30** well, but found **Questions 5**, **11**, **13**, **17**, **19**, **24** and **26** more difficult.

Comments on specific questions

Question 2

A number of candidates did not recognise that in the first 5 s that the car was accelerating from rest. Consequently for those 5 s the average speed was half the maximum speed.

Question 5

Many candidates thought that the mass of the object increased when taken to the second planet.

Question 7

There was often confusion between the terms “length of a spring” and “extension of the spring”.

Question 8

Although this was answered correctly by many candidates, all three incorrect options were selected by other candidates indicating that many of them may have guessed at the answer.

Question 11

Candidates did not seem familiar with this activity. All options were selected and this indicated that many, including the better candidates, were unsure of the answer.

Question 13

The majority of candidates thought that the distance from the bottom of the barometer tube, rather than the reservoir surface, to the mercury level in the tube was the required distance.

Question 17

Few candidates showed an understanding of thermal capacity, with the majority thinking that the oil had the higher thermal capacity.

Question 19

There was little understanding of the cause of convection currents. Many candidates did not recognise that in this example it was cooling, as opposed to the more familiar heating which produced the current.

Question 24

This question proved challenging with all responses being selected in almost equal numbers.

Question 26

Most candidates failed to recognise that with an echo, the sound has to travel to the reflecting surface and back again.

Question 27

Many candidates did not demonstrate a knowledge of the properties of magnetically hard and magnetically soft metals.

Question 32

Stronger candidates knew that the resistance of two resistors in parallel is less than either of the two individual resistors. Most thought that the resistances simply added up.

Question 34

This was a challenging question but a significant number of candidates answered correctly.

Question 35

In many cases candidates were not aware that the fuse in a circuit should be in the live line and that if a fuse in the neutral line blows then the potential difference between the live line and earth will remain high.

PHYSICS

Paper 0625/12
Multiple Choice Core

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

Key messages

Many candidates found this paper challenging and did not have the basic knowledge or understanding to answer many of the questions. Nevertheless there were also some stronger candidates who showed some understanding.

General comments

Candidates answered **Questions 4**, **9**, **16**, **19**, **21** and **27** well. However in general candidates found the test challenging with **Questions 1**, **3**, **5**, **11**, **13**, **14**, **17**, **24**, **25**, **33** and **40** only answered correctly by the strongest candidates.

Comments on specific questions

Question 1

The majority of candidates correctly calculated the change in height of the oil level but then failed to convert the minutes into seconds.

Question 2

Candidates generally just multiplied the maximum speed of the vehicle by the time taken. However, they should have recognised that the car was accelerating and that the distance travelled was equal to the area under the graph ($\frac{1}{2}$ maximum speed · time).

Question 3

Most candidates subtracted the starting speed from the final speed and divided by 2, rather than adding the speeds before dividing by 2.

Question 5

The vast majority of candidates thought that both the mass of the object and its weight increased when taken to the second planet.

Question 7

The majority of candidates thought that for the aircraft to travel at a constant speed, the driving force must be greater than the drag forces. Many also thought that for level flight the upward force must be greater than the weight of the aircraft.

Question 11

Candidates did not seem familiar with this activity. All options were selected and this indicated that many, including the better candidates, were unsure of the answer.

Question 12

Although a number of candidates correctly calculated the answer, an equal number simply multiplied the 400 by 0.02 not recognising that force is measured in newtons, not grams and that pressure is force divided by area.

Question 13

The majority of candidates thought that the distance from the bottom of the barometer tube, rather than the reservoir surface, to the mercury level in the tube was the required distance.

Question 14

Candidates were unsure of Brownian motion and there was evidence of guessing by most candidates with all options chosen.

Question 17

Few candidates showed an understanding of thermal capacity, with many thinking that the oil had the higher thermal capacity.

Question 22

Many candidates found this question challenging. Candidates would have benefited from observing wavefronts reflecting from barriers in order to gain an understanding of the behaviour of waves.

Question 24

Candidates had difficulty in understanding that the angle of refraction is the angle between the normal to the surface and the ray, rather than the angle between the surface and the ray and the majority of candidates therefore incorrectly gave option **A** as their answer.

Question 25

Few candidates were able to answer this question correctly.

Question 28

Candidates did not generally show an understanding of the properties of magnetically hard and magnetically soft metals.

Question 29

Only the strongest candidates answered correctly and worked out the poles induced on the ends of the magnets by the gap (both north-seeking poles) and then recognised that like poles repel each other.

Question 31

Stronger candidates were able to answer this question correctly and recognised that doubling the diameter quarters the resistance (not halving it as the resistance is inversely proportional to the cross sectional area) and that doubling the length doubles the resistance.

Question 33

Candidates struggled with this question with many being distracted by the LDR and thinking it must be the change in light level which would decrease the speed of the motor. However an increase in the light level would reduce the resistance of the LDR, increasing the current and increasing the speed of the motor.

Question 34

This was only answered correctly by the strongest candidates.

Question 35

Candidates were not aware that the fuse in a circuit should be connected in series with the appliance that is to be protected and in the live line. If a fuse in the neutral line blows then the potential difference between the live line and earth will remain high.

Question 37

The majority of candidates did not recognise that the two changes cancelled each other out. However stronger candidates recognised that swapping the poles reverses the direction of the force on the wire and changing the current direction also reverses the direction of the force, hence returning it to the original direction.

Question 40

This question proved challenging with all options chosen equally.

PHYSICS

Paper 0625/13
Multiple Choice Core

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

Key messages

Many candidates found this paper challenging and did not have the basic knowledge or understanding to answer many of the questions. Nevertheless there were also some stronger candidates who showed some understanding.

General comments

Candidates answered **Questions 1**, **3**, **7**, **14**, and **26** well. **Questions 2**, **11**, **12**, **17**, **21**, **23**, **25**, **27**, **31**, **33** and **36** only answered correctly by the stronger candidates.

Comments on specific questions

Question 1

This question was generally well answered.

Question 2

Virtually all candidates recognised that the graph was a straight line from the origin. Unfortunately, very few recognised that the distance travelled is equal to the area under the graph which is $\frac{1}{2}v_{max} x\ t$, not $v_{max} x\ t$.

Question 5

The vast majority of candidates thought that both the mass of the object and its weight increased when taken to the second planet.

Question 11

Candidates did not seem familiar with this activity. All options were selected and this indicated that many, including the better candidates, were unsure of the answer.

Question 12

The majority of candidates thought that the distance from the bottom of the barometer tube, rather than the reservoir surface, to the mercury level in the tube was the required distance.

Question 16

Radio-active decay is spontaneous and does not depend upon external conditions (including temperature) hence cannot be used to measure temperature. Although some candidates got this correct, there was a significant number who thought that the length of a metal bar could not be used to measure temperature.

Question 17

Few candidates showed an understanding of thermal capacity, with many thinking that the oil had the higher thermal capacity.

Question 21

Although nearly all candidates rejected option **A**, the remaining three options were roughly equally popular, suggesting that many candidates have never carried out this type of experiment.

Question 23

This question proved challenging for many candidates with both responses **A** and **C** being frequently chosen.

Question 25

Stronger candidates answered this question correctly and knew the range of frequencies that the human ear can detect and that ultrasound is sound of higher frequency than the sounds we can hear and will travel at the same speed as the sound we can hear.

Question 27

Candidates did not generally show an understanding of the properties of magnetically hard and magnetically soft metals.

Question 30

Although most candidates recognised the symbol as a LDR, the majority thought that its resistance increased as the light levels increased.

Question 33

This was only answered correctly by the strongest candidates.

Question 35

This question proved challenging. Candidates needed to recognise that the primary coil must have more turns than the secondary. This limited the answers to **C** and **D**. Candidates then needed to calculate the ratio of the voltages (50 : 1), which must be the same as the ratio of the numbers of turns.

Question 36

The vast majority of candidates chose option **A**. However, that option showed a uniform field and the circles are evenly spaced. The magnetic field decreases as you move further away from the wire therefore the increase in diameter of the circles increase by an increasing amount as you move away from the wire.

Question 38

This question was challenging for most candidates. Only the strongest candidates showed an understanding of nuclide notation. The upper figure showed the number of protons (11), which limited the possible answers to **B** and **C**. However, the lower number showed the number of neutrons plus protons so must be larger than the upper number, leading to the correct answer of **C**.

Question 40

The question tested candidates understanding of half-life. Only stronger candidates were able to answer correctly.

PHYSICS

Paper 0625/21
Multiple Choice Extended

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

Key messages

Although there were some strong candidates, there were a number who found this paper very challenging.

General comments

Candidates answered **Questions 1**, **4**, **5**, **7**, **16**, **21**, **29** and **35** well, but found **Questions 9**, **12**, **17**, **24**, **26**, **30**, **36** and **40** difficult.

Comments on specific questions

Question 1

The majority of candidates answered this question correctly.

Question 8

The question was answered correctly by a significant number of candidates. However, some candidates simply added the two forces as though they were acting in the same direction.

Question 9

This question proved very challenging for the majority of candidates. Only the very strongest candidates recognised that the change in velocity of the ball was 25–(–40) = 65 m/s, not (25–40) = 15 m/s.

Question 10

Many candidates found this question difficult. Stronger candidates were able to use the simple law of conservation of energy (total energy at **X**=total energy at **Y)** to answer however.

Question 12

Candidates did not seem familiar with this activity, with all options being chosen fairly equally.

Question 13

Many candidates thought that the distance from the bottom of the barometer tube and from the reservoir surface to the mercury level in the tube was the required distance.

Question 14

Most candidates correctly identified that the movement of the mercury in the tube was due to the air expanding but a number thought it was due to the expansion of the mercury.

Question 17

Many candidates answered this question correctly but a significant number thought the bending of the bimetal strip was caused by the iron contracting more than the brass. Contraction is mentioned in the stem of the question and it is possible that candidates were distracted by this. Candidates should be reminded to read the question carefully so that the context is fully understood.

Question 18

A number of candidates forgot to convert grams to kilograms in answering this question.

Question 19

There was little understanding of the cause of convection currents. Many candidates did not recognise that in this example it was cooling, as opposed to the more familiar heating which produced the current.

Question 24

This question was challenging for most candidates. Common errors were failing to convert kilometres to metres and not allowing for the time for the light to travel both to and from the moon.

Question 25

Many candidates were unclear about the nature of ultrasound. More candidates selected option **D** than the key, **B**.

Question 30

Only the strongest candidates answered this question correctly.

Question 34

This question was answered quite well, showing a good understanding of potential dividers.

Question 36

Most candidates showed an understanding of the three dimensional nature of electromagnetic induction. However, many then chose the movement upwards, rather than downwards.

Question 37

The most common error candidates made was not to recognise that when the coil is spun at a greater speed the frequency increases and the induced e.m.f. also increases.

Question 40

While this was a challenging question, stronger candidates recognised that the background count must be allowed for when taking readings from the graph.

PHYSICS

Paper 0625/22
Multiple Choice Extended

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

Key Messages

Stronger candidates were able to show a thorough knowledge of the basic facts, relationships between quantities and a good understanding of a range of concepts.

General Comments

Candidates answered **Questions 4**, **5**, **7**, **10**, **11**, **15**, **17**, **18**, **27** and **30** well, but found **Questions 9**, **12**, **23**, **24,** and **25** difficult.

Comments on specific questions

Question 3

Many candidates gave the correct answer for this question although a number failed to recognise the effect of the Earth's atmosphere when an object is falling through it.

Question 6

The most common error made on this question was to use the distance from the point of action of the force to the point **P**, rather than the perpendicular distance from the line of action of the force to **P**.

Question 8

Although this was answered correctly by a significant number of candidates, many simply added the two forces as though they were acting in the same direction.

Question 9

This question was challenging for many candidates. The most common error seen was not recognising that the change in velocity of the ball was 25–(–40)=65 m/s, not (25–40)=15 m/s.

Question 12

Many candidates did not seem familiar with this activity, with all options chosen fairly equally.

Question 13

Although the question was answered well by many candidates, a significant number thought that the distance from the bottom of the barometer tube to the mercury level in the tube was the measurement which gives the atmospheric pressure.

Question 16

Most candidates correctly identified that the movement of the mercury in the tube was due to the air expanding but a number incorrectly thought it was due to the expansion of the mercury.

Question 23

Only the strongest candidates answered this question correctly.

Question 24

This question proved challenging for many candidates. Common errors were to fail to convert kilometres to metres and to not allow for the time for the light to travel both to and from the moon. Only the strongest candidates answered this correctly.

Question 25

Many candidates were unclear about the nature of ultrasound. More candidates selected option **D** than the key, **B**.

Question 30

Many candidates found this question challenging. Stronger candidates were able to show an understanding of the movement of charge to answer successfully.

Question 33

Whilst nearly all candidates recognised that that the energy converted is measured in the unit joules, a significant number mistakenly took 60 seconds an hour.

Question 34

This question was answered well showing a good understanding of potential dividers.

Question 36

Most candidates showed an understanding of the three dimensional nature of motor effect and the majority chose the correct sense of the movement.

PHYSICS

Paper 0625/23
Multiple Choice Extended

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

Key messages

Many candidates were able to show a thorough knowledge of the basic facts and relationships between quantities and had a good understanding of a range of concepts.

General comments

Candidates answered **Questions 1**, **4**, **7**, **15**, **20**, **26**, **30**, **37** and **39** well, but found **Questions 3**, **24**, **27, 33** and **36** more challenging.

Comments on specific questions

Question 1

This was answered correctly by most candidates.

Question 3

Candidates found this question one of the most challenging on the paper. It appeared that many candidates thought that because the ball is still falling with an increasing velocity then there must be an increasing acceleration.

Question 5

Although there were many candidates who answered correctly, option **B** was often chosen with these candidates knowing that this is a true statement (even though it does not explain why all objects fall with the same acceleration) without checking the remaining options carefully.

Question 8

The question was answered correctly by the majority of candidates, but some simply added the two forces as though they were acting in the same direction.

Question 11

The majority of candidates answered correctly but a significant minority made the error of thinking that the CFL lamp gave out the most light energy. To show which lamp gives out the most energy a simple calculation needed to be done (10% of 150 W = 15 W; 30% of 40 W = 12 W).

Question 13

Nearly equal numbers of candidates thought that the distance from the bottom of the barometer tube and from the reservoir surface, to the mercury level in the tube was the required distance.

Question 21

This was answered correctly by many candidates but a significant number gave the wrong option.

Question 24

This question was only answered correctly by stronger candidates. Common errors were failing to convert kilometres to metres and not allowing for the time for the light to travel both to and from the moon.

Question 27

Many candidates were unclear about the nature of ultrasound. More candidates selected option **D** than the key, **B**.

Question 33

This question proved challenging for many candidates.

Question 34

This question was answered quite well, showing a good understanding of potential dividers.

Question 36

Stronger candidates were able to recognise the application of the concept that an induced e.m.f. tends to oppose the change causing it.

PHYSICS

Paper 0625/31
Paper 3 Core

Key messages

In calculations, candidates should be reminded to set out and explain their working clearly. This will allow for partial credit to be awarded for any correct working even when an incorrect final answer is given.
Candidates should ensure their answers are clear and 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.

General comments

Many candidates were well prepared for this paper. However, a significant number of candidates struggled to recall equations.

Often candidates were able to apply their knowledge and understanding to fairly standard situations. However sometimes they were less secure when applying this to a new situation, and some displayed a lack of breadth of understanding. Stronger candidates were able to think through the possibilities and apply their knowledge when the question asked for suggestions to explain new situations.

The questions on total internal reflection, diffraction, plotting magnetic field patterns, advantages of high voltage transmission of electrical energy and means of reducing the risks when working with radioactive sources were generally only answered well by stronger candidates. There were a significant number of candidates who either did not read the questions carefully enough, or gave answers that were related to the topic being tested, but did not answer the question exactly as it had been set.

While most candidates showed an adequate control of English to answer the questions, some candidates were not able to express themselves adequately.

Comments on specific questions

Question 1

(a) Most candidates correctly gave the name of a suitable timing device.

(b) The vast majority of candidates gave responses which indicated improved accuracy as the reason for timing 10 oscillations.

(c) (i) Most candidates identified the third result as being incorrect. However, a very large percentage of candidates chose the second result, presumably as it was the only measurement beginning with 4.

(ii) Most candidates were able to gain full credit by calculating an average value for the results in the table. Weaker candidates often failed to divide by the number of readings, with many dividing by 2 to give an average.

(iii) The majority of candidates correctly divided the average time in **(ii)** by 10, and quoted their answer to two significant figures. A common error amongst weaker candidates was to divide by either 4 or by 2.

Question 2

(a) Many candidates answered fully correctly and gave clear and detailed descriptions of how to determine the average speed of the stick. However, weaker candidates gave vague and imprecise statements.

(b) Many candidates answered correctly, but most thought that to move with constant speed the forward force is greater than the backward force or only a forward force acts.

Question 3

(a) The majority of candidates correctly calculated the resultant force on the marker. A common error was to give the direction as north rather than up the page or in the direction of the 280 N force. Weaker candidates added or divided the forces.

(b) Only the stronger candidates answered this question fully correctly. Many candidates gave answers which were too vague or imprecise. A significant number of candidates failed to read the question carefully, or just gave a description of a method to find the volume of one of the links.

Question 4

(a) The vast majority of candidates identified both energy sources.

(b) (i) This question was generally well answered. Most candidates gave at least one advantage of using renewable energy sources for generating electricity.

(ii) Candidates generally answered this question well, with many candidates giving a clear disadvantage of renewable energy sources.

Question 5

The majority of candidates gained full credit for this question. The most common error was to confuse lowest and highest, and so in **(b)** these candidates gave “solid” instead of “gas” as the answer.

Question 6

(a) Many candidates answered correctly by drawing a ray refracted away from the normal. Common errors were to refract the ray towards the normal, or to just draw a reflected ray. A significant number of candidates failed to draw any ray.

(b) (i) Many candidates answered well but weaker candidates were not precise enough in estimating the angle of reflection. A common error was to draw a ray refracted into the air.

(ii) The majority of candidates only gave the word “reflected” as their answer. Only the stronger candidates gave the correct term of “totally internally reflected”.

(c) The majority of candidates drew three wave fronts that were diffracted after the barrier, but many answers lacked precision, and consequently the wavelengths of the diffracted wave fronts were either much greater or much smaller than the waves approaching the barrier.

Question 7

(a) (i) Many candidates failed to read the question carefully and merely drew one arrow on the diagram.

(ii) The vast majority of candidates identified sound waves as being longitudinal.

(ii) Most candidates answered this question well. The most common error was to give either a wrong unit or to omit the unit altogether.

(iv) Most candidates identified ultrasound as a sound wave having a frequency above the range of normal human hearing. The most common error was to state that ultrasound is below the lowest frequency audible to the human ear.

(b) (i) The majority of candidates correctly calculated the speed of ultrasound in sea water. Weaker candidates often multiplied their two values from the graph rather than dividing distance by time.

(ii) The majority of candidates gained partial credit for this item. The most common error was failing to divide their distance by two.

Question 8

(a) Many candidates found this question challenging, with very few answering fully correctly. Most candidates merely stated that the plotting compass would point to either the north or the south pole of the bar magnet.

(b) The majority of candidates drew accurate field patterns. Common mistakes were to have field lines crossing, or to have an incorrect direction for the magnetic field.

Question 9

(a) (i) Most candidates correctly labelled the thermistor. However, many candidates inaccurately labelled the variable resistor as a thermistor.

(ii) Many candidates gained full credit for this question but a significant number of candidates drew the voltmeter in series with the thermistor and variable resistor.

(b) (i) Many candidates answered fully correctly here. The most common errors were either an incorrect transformation of the equation, or weaker candidates using an incorrect equation of resistance = voltage divided by temperature.

(ii) Most candidates recognised that the current in the thermistor would increase, and more able candidates went on to explain that this was as a result of a decrease in the resistance of the thermistor.

(iii) Almost all candidates suggested a suitable value for the current in the thermistor at the higher temperature.

(c) Most candidates correctly calculated the combined resistance. However weaker candidates subtracted one value from the other.

Question 10

(a) (i) The concept of electromagnetic induction was well understood by the majority of candidates and consequently many gained full credit.

(ii) Many candidates gave two descriptions of sensible methods of increasing the induced electromotive force. However, many candidates gave poor descriptions of winding the wire to form a coil.

(b) Most candidates recalled and used the transformer equation with most going on to gain full credit. A common error was in rearranging the equation after substitution. Weaker candidates attempted some form of cross multiplication of quantities in the question which was not usually successful.

(c) Many candidates gained partial credit, but only the strongest gave two advantages of high voltage transmission of electrical energy for full credit.

Question 11

(a) The majority of candidates had a good grasp of nuclide notation. A common error was to state the number of nucleons as being the number of protons.

(b) Most candidates were able to state the names of two types of radiation emitted when radioactive elements decay. Weaker candidates often stated various components of the electromagnetic spectrum.

(c) Only the strongest candidates were able to give an accurate calculation of the time for the sample to decay.

Question 12

(a) Many candidates gained partial credit for identifying one of the effects of radiation on the human body, but very few went on to explain that this was due to the ionising capability of the radiation.

(b) The majority of candidates gained partial credit on this item, usually for describing some form of shielding. More able candidates went on to describe a second method of reducing the risk. Many weaker candidates only gave simplistic answers such as “wearing protective clothing” which was not sufficient for credit.

PHYSICS

Paper 0625/32
Core Theory

Key messages

- Candidates should be reminded to state equations and show their working when completing calculations. This may allow for partial credit to be awarded for any correct working where the final answer is incorrect.
- Candidates would benefit from being provided with further opportunities to apply their physics understanding to a wider range of contexts to prepare for the paper.
- Candidates should be advised to check through their responses. Errors such as failing to answer part of a question, the omission of a unit or checking that the appropriate number of ticks has been used in a tick box question can then be avoided.

General comments

A high proportion of candidates attempted all questions. A small but significant number of candidates scored very high marks and could have benefitted from being prepared and entered for the extended theory paper. Candidates demonstrated appropriate language skills and there was no evidence of candidates having insufficient time to complete the questions. In a very small number of cases credit could not be given for responses that were illegible.

There were some areas of the syllabus that provided greater challenge to candidates and these included the questions on energy transfer, electromagnetism and radioactivity. Most candidates were able to use and apply standard equations such as the pressure and transformer equations. In a small but significant number of cases candidates left parts of a question unanswered suggesting that topics had not been covered well or that knowledge and understanding was not secure.

Comments on specific questions

Question 1

(a) There were a high proportion of correct responses to this question.

(b) This question was only answered well by the strongest candidates. There were many vague responses which included information on wind and wave turbines, solar panels or hydroelectric pumping stations.

Question 2

(a) Sections A and B were answered well by nearly all candidates. A small proportion of candidates indicated that the vessel was stationary at Section B. Only the better prepared candidates gained full credit indicating faster rate and higher speeds for Sections C and D.

(b) Many candidates gave an incorrect response of 4 m, failing to take account of the time in minutes. In many cases credit for any correct working could not be awarded as candidates had not given an equation or shown their calculations.

Question 3

(a) (i) This question was answered well by stronger candidates.

(ii) This was answered well by stronger candidates. Common errors were 45 and 4500.

(b) Many candidates answered this correctly.

Question 4

(a) This question was answered correctly by stronger candidates. A common incorrect response was "gravitational energy".

(b) There were many correct responses to this question. Incorrect responses usually indicated a point at the maximum displacement from the mid-point. There were a significant number of candidates who did not give a response to this question.

(c) Stronger candidates were able to answer this question correctly. Common incorrect responses referred to gravitational force or resultant force.

(d) This question proved challenging to many candidates but stronger candidates were able to answer correctly.

Question 5

(a) This was a challenging question for many candidates. Examples of insulators such as plastic and air were frequently seen and could not be credited.

(b) Many candidates gained at least partial credit for their responses to this question recognising conduction, convection and evaporation as thermal energy transfer mechanisms. There was some evidence of candidates who had learned a response giving their answers in terms of air rather than a liquid.

Question 6

(a) There were many partially correct responses to this question. A common error was with the positioning of the angle of reflection. A small number of candidates failed to obtain credit for the last part stating that the incident ray was equal to the reflected ray rather than referring to the angles of incidence and reflection.

(b) This was answered well by stronger candidates.

(c) This question was answered well by many candidates. However few candidates were able to give a correct response for the focal length and 24 cm was a common wrong answer.

Question 7

(a) Purple and pink were common errors seen in answers to this question.

(b) Stronger candidates were able to answer both parts of this question correctly.

(c) Cancer was a common incorrect answer.

(d) Many candidates gave a range of acceptable responses. Sound, longitudinal and transverse waves were common incorrect responses that could not be credited.

Question 8

(a) This was answered well by stronger candidates.

(b) Almost all candidates gave correct answers for both parts of this question.

(c) Many candidates gained full credit for their answers to this question. However, a significant number of candidates did not give a response to **(ii)**.

Question 9

(a) Iron was a common incorrect answer in this question.

(b) Many candidates gained at least partial credit for their responses to this question recognising that the flow of current through a coil had a magnetic field.

(c) This question proved challenging for many candidates. A significant number of candidates did not provide any response.

Question 10

(a) (i) Only the strongest candidates answered this question correctly. Common incorrect responses were 3.57 Ω and 14.4 Ω.

(ii) This question proved challenging for many candidates.

(b) Only the strongest candidates gained full credit for this question.

Question 11

(a) Many correct responses were seen for this question.

(b) This was answered well by nearly all candidates.

(c) Many candidates answered this question correctly.

Question 12

(a) Most candidates answered all parts of this question correctly.

(b) Many candidates gained at least partial credit and stronger candidates gained full credit for this question.

PHYSICS

Paper 0625/33
Core Theory

Key messages

Candidates should note the number of marks available and the space allocated for responses as these factors provide a clear indication of the type of answer that is expected.

Candidates should be reminded to state equations and show their working when completing calculations. This may allow for partial credit to be awarded for any correct working where the final answer is incorrect.

Candidates would benefit from being provided with further opportunities to apply their physics understanding to a wider range of contexts to prepare for the paper.

Candidates should be advised to check through their responses. Errors such as failing to answer part of a question, the omission of a unit or checking that the appropriate number of ticks has been used in a tick box question can then be avoided.

General comments

Most candidates completed all questions on the paper but in a small but significant number of cases candidates left parts of a question unanswered suggesting that topics had not been covered well or that knowledge and understanding was not secure. Candidates demonstrated appropriate language skills and there was no evidence of candidates having insufficient time to complete the questions. In a very small number of cases credit could not be given for responses that were illegible.

There were some areas of the syllabus that provided greater challenge to candidates and these included the questions on waves, electrical circuits and radioactivity. The questions on the mechanics and thermal properties sections of the syllabus produced the best responses from candidates. Many candidates were able to score well in numerical questions that required the use of a standard equation.

Comments on specific questions

Question 1

(a) (i) A very high proportion of correct responses were seen.

(ii) Nearly all candidates answered this correctly.

(b) (i) This question was usually well answered. Some partially correct responses were seen, for example, 360 instead of the required 6 minutes.

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

Question 2

(a) Stronger candidates gained full credit for this question. Many other candidates were able to gain partial credit for their answers. A small proportion of candidates made no response.

(b) Many candidates gained full credit for their calculation of density. A small number of candidates gave an incorrect value for the density without stating an equation or showing the steps in their calculation.

Question 3

(a) This question was answered well by most candidates.

(b) (i) This question was well answered by most candidates. However many candidates could not be credited for the unit as they gave N/m or N/cm.

(ii) This was well answered by nearly all candidates. A small proportion of candidates made no response.

Question 4

(a) Stronger candidates were able to answer this fully correctly. Many candidates gained some credit for partially correct responses.

(b) This was answered correctly by most candidates.

Question 5

(a) Many correct responses were seen for this question. A frequent misconception was that tyres with smaller surface area would be less likely to get stuck in the soft ground.

(b) Many candidates gained at least partial credit for their responses to this question recognising that molecules move faster or more frequently collide with the tyre.

Question 6

(a) (i) This was well answered by nearly all candidates.

(ii) The majority of candidates placed their arrow at 0°C. There were some candidates who did not complete this question.

(iii) This question proved challenging for most candidates. Nearly all candidates believed that the fixed points were – 10°C and 110°C.

(b) Most candidates gained at least partial credit for this question. A common misconception was that a dull black surface is a good insulator.

Question 7

(a) This was answered well by only the stronger candidates.

(b) 24 was a common incorrect answer given for this question.

(c) Stronger candidates were able to answer this correctly.

(d) Very few candidates were able to give a correct answer to this question. Many candidates did not give a response to this question or the next question.

(e) This question was not well answered and “sound” was a very common incorrect response.

Question 8

(a) (i) Many candidates gained partial credit for their responses. Few candidates were able to correctly show the refraction within the lens.

(ii) F_1 to F_2 was a common incorrect response seen for this question.

(b) Only the strongest candidates gained any credit for this question. A significant proportion of candidates did not give any answer to either part.

Question 9

(a) This was well answered by almost all candidates.

(b) Many candidates answered this question well.

(c) Incorrect responses to this question often included vague comments about wavelength and/or frequency changing.

Question 10

(a) Relatively few fully correct responses were seen.

(b) Only the very best candidates gained full credit recognising that the test for a magnet was repulsion at one end.

Question 11

(a) Many correct responses were seen from stronger candidates.

(b) This was answered well by many candidates.

(c) Many candidates gained at least partial credit for this question.

Question 12

(a) This question was challenging for many candidates. A significant proportion of candidates did not give a response to any part of this question.

(b) This question was not answered well and many candidates failed to give any response.

(c) Only the strongest candidates gained full credit for this question.

PHYSICS

Paper 0625/41
Extended Theory

Key messages

- Candidates should be reminded to check that they have included units in their answers where required and that these are correct.
- Candidates are advised to use kg, m and s in calculations wherever possible.

General comments

Many candidates performed well on the paper. However, some of the weaker candidates failed to complete the paper, either due to lack of time or lack of knowledge in certain areas of the syllabus.

Most candidates answered questions involving calculation and recall of formulae well. Generally, candidates wrote down formulae before substituting numbers, which allowed for at least partial credit to be awarded even if no further progress was made. However, this year a significant number of candidates made errors in giving units or failed to give units altogether.

Performance on questions requiring descriptions and explanations varied. It was clear that many candidates had not read some questions with sufficient care or in sufficient detail. This is an essential skill and candidates should be reminded to read all questions carefully.

Comments on specific questions

Question 1

(a) (i) A majority of candidates realised that the distance required was given by the triangular area under the graph and calculated the distance correctly. Many weaker candidates simply used distance = speed × time and failed to gain credit.

(ii) Most candidates wrote down an applicable formula for calculating acceleration and gained partial credit. Many of these candidates then selected the correct data from the graph and calculated the required acceleration. However, others read the graph incorrectly.

(iii) The formula F = ma was well known. In general, those failing to calculate the force correctly used the wrong acceleration, sometimes the acceleration of gravity, but other incorrect numbers were used. Wrong acceleration values carried forward from **(ii)** allowed some candidates to gain partial credit.

(b) This question was challenging for many candidates and a variety of answers were seen. However stronger candidates identified decreasing acceleration or decreasing rate of increase in speed and could be credited.

Question 2

(a) The correct proportionality between force, load or weight and extension needed to be identified in answers to this question. Alternatively a reference to F = *kx* with the symbols explained was also accepted. It was insufficient to state 'extension increases with load'.

(b) (i) Almost all the candidates drew the correct graph.

(ii) Most candidates correctly calculated the correct numerical number using F = *kx. Many* candidates, however, did not state the unit.

(c) Only the strongest candidates gained full credit for stating that the elastic limit or limit of proportionality had been exceeded and that the spring no longer obeyed Hooke law.

Question 3

(a) Most answers correctly referred to mass as quantity or amount of matter. Answers that mentioned weight or gravity could not be credited.

(b) (i) Use of mass/volume could almost always be credited. Many candidates sensibly decided to work in kg and m^3. Having calculated the volume as 512 cm^3, only the strongest candidates were able to make the correct conversion to m^3. Those who converted the linear dimensions of cm to m before calculating the volume of the cube were more successful.

(ii) Many candidates, some with the benefit of carrying forward an error in the density in **(ii)**, gave a correct answer here. However some candidates came to the wrong conclusion, usually because the density of the cube had not been calculated in $kg/m^{3.}$

(c) (i) A statement of W = mg or correct substitution into this formula gained partial credit for this question and was generally seen. However, the unit was often omitted or wrong in answers. Stronger candidates were able to gain full credit.

(ii) Most candidates answered correctly. Substitution into the formula required the depth as 0.030 m. Many candidates substituted the value in cm.

Question 4

(a) Three steps were needed in the explanation. Most candidates wrote correctly about collisions with the balloon wall, or rebound of the atoms from the balloon wall. Few candidates referred to the change of momentum of these atoms. A very small minority of candidates then went on to add that the rate of change of momentum of the atoms gives the force.

(b) (i) The fact that fewer atoms per unit volume were present could have been expressed in several ways and the simplest way was to state that the atoms become further apart. Many candidates gained partial credit for this point. Fewer answers expressed the idea that the rate of collision of atoms with the wall of the balloon would then be smaller.

(ii) Most candidates realised that the calculation of the pressure required the application of Boyle's law. Many candidates correctly calculated the correct pressure. Weaker candidates made a substitution of a quantity with the wrong unit however.

Question 5

(a) Most candidates answered this question correctly.

(b) (i) Many candidates gained at least partial credit for this question and the stronger gainer full credit.

(ii) Many candidates gained full credit for this question. However sometimes the working was difficult to follow. In many cases candidates giving an incorrect answer gained partial credit for giving a correct formula relating speed, frequency and wavelength and for showing that the frequency of the waves was the same in both the deeper and shallower water.

Question 6

(a) In general, candidates showed good recall of the speeds of sound in solids, liquids and gases.

(b)(i) Many candidates placed the letters X and Y in suitable positions. However weaker candidates did not study the figure carefully enough.

(ii) Most candidates answered this question well.

(iii) Many candidates calculated the total distance travelled by the laser beam to the Moon and back to the Earth, but then failed to halve this distance.

Question 7

(a) Many candidates drew two acceptable rays and gained partial credit. However, a number of candidates failed to label the image or show that the image formed by these rays was inverted.

(b) The majority of candidates could not underline more than one correct description for this question.

(c) Recall of a picture of the spectrum of white light formed by a prism was needed to answer this question. Many candidates were able to use this to answer the question. However, some candidates failed to show the separation of the colours within the prism. Others showed the separation of the colours within the prism, but drew the emerging ray parallel to the red one.

Question 8

(a) The vast majority of candidates chose to describe hydroelectric power. The first step for many was to refer to the spinning of a turbine without mentioning the potential energy of stored water or the kinetic energy of falling water that precedes this. Reference to the action of a generator was not often seen.

Some candidates chose to write about tidal power but this was not often done well. As with hydroelectric power, the common feature was to refer to a turbine but to omit any mention of the kinetic energy of the water and a generator.

A small number of candidates wrote about wave power but they frequently showed little knowledge of the mechanism.

(b) The concept of renewability was only well understood by stronger candidates.

In general, most candidates writing about hydroelectric power suggested that renewability is confirmed by a constant supply of water, and not how rain is required to replenish the water held behind a dam, and occurs through the action of the Sun.

Candidates writing about tidal power did not refer to it being caused by the action of the Moon (and the Sun), which are always in place.

The effect of the wind and its cause was not mentioned in any of answers seen from candidates writing about wave power.

(c) A significant proportion of candidates writing about hydroelectric power stated that the Sun is not the source of energy, and no credit could be awarded. Those who suggested that the Sun is the source gained some credit. Only a few of the explanations that followed described the action of the Sun in evaporating water, or the subsequent condensation of the vapour and the production of rain to replenish the water behind a dam.

Explanations of tidal power were generally not strong. Acceptable answers about whether the Sun is the source of energy would have depended on whether only the Moon or both the Sun and the Moon had been mentioned in **(b)**.

Candidates discussing wave power did not address the wind being caused by thermal energy from the Sun.

Question 9

(a) (i) A large number of candidates could not write down the total e.m.f, of the three cells in series.

(ii) Many candidates did not know the formula for calculating the combined resistance of 2 resistors in parallel. Only the strongest candidates who did know the formula were able to use it correctly.

(iii) With the benefit of carrying forward an error from **(i)**, full credit could be awarded to most answers.

(b) Some of the suggestions for placing the ammeter and the voltmeter were not expressed very clearly. However, in **(i)** and **(ii),** most of the suggested positions for the meters were acceptable. The exception was for those who wrote down "at B" or "at G" for the ammeter.

Question 10

(a) (i) Many candidates were able to provide the drawing of the symbol for a diode.

(ii) Most candidates could state the function of a diode well.

(b) (i) Many candidates completed the circuit correctly, with a diode drawn with the correct orientation.

(ii) Many answers, even from the strongest candidates, were confused. The alternating nature of the magnetic field produced by coil Y was often missed, as was the linking of this field with coil X or its cutting by coil X. Partial credit could be awarded for some answers which stated that voltage or current is induced in coil X by electromagnetic induction.

Question 11

(a) (i) Few candidates knew that β-particles are electrons and only the very strongest knew that they are produced in the nucleus of the emitting atom.

(ii) Those candidates who knew the nuclear symbol for a β-particle, generally completed the nuclide equation and gain full credit. Those who could not recall the β-particle symbol could nevertheless be awarded partial credit for producing an equation in which the proton numbers and nucleon numbers balanced.

(b) Only the stronger candidates answered this question correctly. Many answers began "half-life is half the time it takes for ..." and could not be credited. Even those did not make this error frequently showed confusion about what quantity was halved in the duration of the half-life.

(c) For **(i)** and **(ii),** many candidates gave answers relating to the penetrating properties of α-particles and γ-rays, rather than relating the situation to the question. However, for **(i)** many candidates correctly stated that α-particles would not penetrate the plastic. In **(ii),** fewer candidates provided an acceptable reason why γ-rays would not be suitable, often writing about the dangers associated with their use.

PHYSICS

Paper 0625/42
Extended Theory

Key messages

- Most candidates would benefit from more practice in applying their knowledge in unfamiliar situations. This would deepen candidates' understanding. Many candidates, when asked to apply their knowledge to a new situation, were unable to use the knowledge they have. This was most evident in responses to **Questions 9(a)(ii)** and **10(b)**.
- It is essential that candidates show their working and write down the equations. This may enable them to gain partial credit where some correct working is given with an incorrect final answer.

General comments

Most candidates demonstrated a good understanding in their answers. Equations were generally well known and were well used by stronger candidates. However, the knowledge and use of equations and the quantities represented were not always understood by weaker candidates. There appeared to be many cases of reliance on rote learning of equations with insufficient understanding of how they should be applied. There were frequent examples in **Questions 1(c)(i)**, **2(c)(i)** and **(ii)** and **4(b)(ii)** where candidates substituted values into the wrong equations involving similar quantities. The use of units by most candidates was good.

Most candidates followed the instructions for the questions. However, some candidates gave more than one answer to a question or chose an answer that might cover two situations. Candidates needed to commit to an answer. Some candidates did not read the questions carefully enough and wrote known standard facts when, in fact, the question required the application of these facts.

Overall the English language ability of the vast majority was adequate for the demands of this paper.

Comments on specific questions

Question 1

(a) The vast majority of candidates knew the density equation but many made errors in converting the units of some quantities.

(b) (i) Candidates were able to gain full credit by correctly following on from their answer to **1(a)**, even if that was incorrect. Few incorrect units for weight were seen but a significant number of weaker candidates failed to give any unit.

(ii) This was generally well answered. A minority of candidates just gave the units for mass and weight, which was insufficient.

(c) (i) The majority of candidates knew the equation for the density of the liquid but failed to convert the height of the cylinder into metres, which led to an answer of 20.74 kg/m^3. A number of candidates attempted to use the equations $p=\rho/V$, $p=h\rho$ or $p=mgh$.

(ii) This was generally well answered. A small number of candidates stated that the density of the cylinder was high, which was not sufficient for credit.

Question 2

(a) Many candidates gained credit by writing about an acceleration, deceleration or a change of speed. Only more able candidates recognised they should also include a change in direction.

(b) Many candidates mentioned a change of shape or size but a significant number of others only wrote shape or size with no mention of change which was required for credit.

(c) (i) The majority of candidates gained full credit on this question but a significant proportion used the wrong equation or had unit errors.

(ii) This question was generally well answered.

(iii) This question was generally well answered.

Question 3

(a) The majority of candidates gave a correct fuel and at least part of an adequate description of a process for generating electricity from the chemical energy in the fuel. However, there were many poor responses and candidates were unable to give a step by step description of the process. A significant number of candidates did not read the question carefully enough and gave responses relating to energy sources that did not require combustion.

(b) Stronger candidates were able to give full answers stating that the sun's energy was needed for plants to grow, that plants then died and decayed under pressure to form fossil fuels. Weaker candidates thought that the sun's energy was used by buried dead plants to form a fossil fuel.

(c) Most candidates gained credit for stating that burning fossil fuels was not renewable but only the strongest candidates gave detailed explanations.

Question 4

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

(ii) Most candidates realised that the rate of evaporation increased but a valid explanation was also required to gain full credit. There were many vague explanations about an increase of energy.

(b) (i) This question was generally well answered.

(ii) Most candidates correctly calculated the rate of energy supplied to the water. The most common errors were to either just calculate the energy supplied or to attempt an answer using the specific heat capacity equation. A few candidates worked with both specific latent heat and specific heat capacity equations and gave two answers which could not be credited.

Question 5

(a) Many candidates gained most or full credit on this question. Some responses based on emission were seen which was not relevant.

(b) This question was usually answered corrected.

Question 6

(a) (i) This was nearly always well answered. A number of candidates did not use the necessary scientific term correctly however and caused confusion with other quantities.

(ii) There was a wide spread in the quality of responses to this question. Nearly all candidates drew diagrams that were at least partially correct but there were often significant issues, e.g. no, or very small, curves at the end of straight wavefronts, inconsistent or incorrect wavelengths.

(b) (i) Many candidates gained partial credit for this question but some incorrect answers referred to changes in speed or wavelength.

(ii) This proved challenging for many candidates with few gaining full credit. Many incorrect responses referred to changes in speed, number of wavefronts or were incorrect explanations based on the correct equation $v=f\lambda$.

Question 7

(a) There were many good responses gaining full credit but a few candidates described distances from the lens or wrote contradictory terms e.g. real and virtual, enlarged and diminished.

(b) (i) A lack of precision was frequently seen in answers to this question. Candidates needed to draw reflected rays with an angle of reflection equal to their angle of incidence. Stronger candidates drew careful, correct diagrams gaining full credit.

(ii) Only the strongest candidates answered this question well and drew exemplary, accurate diagrams. These candidates were able to correctly extend both rays back to intersect in the correct position. For the candidates who did not read the question carefully in **(a)(i)** and had only drawn one ray, it was not possible to gain credit here, even if many knew where the image should have been located. Similarly, many candidates drew inaccurate diagrams in **(a)(i)** but knew the correct position of the image. They then extended their incorrectly reflected rays back to the correct image in lines that were clearly not straight and so gained no credit.

Question 8

(a) Many candidates answered this question very well gaining full credit. However, a significant number struggled to deal with the combination of resistors in series and parallel. Nearly all candidates gained at least partial credit for calculating the resistance of the 8 Ω and 4 Ω resistors in series. Many went on to calculate the parallel resistance correctly, but some did not invert their answers at the end. A few candidates also tried incorrectly to combine all three resistors using equations for resistors in series or in parallel. There was often confused and unclear working seen for this question.

(b) This question proved challenging for many candidates. Strong candidates usually calculated the correct answer using the potential divider equation. It was also acceptable to calculate the current through the 8 Ω resistor and then determine the potential difference using Ohm's Law. But many candidates who used this method answered incorrectly e.g. calculating the current using the supply voltage divided by one of the resistor values (8 Ω, 4 Ω or 6 Ω). Consequently final answers for the p.d. in excess of the supply voltage were often seen.

Question 9

(a) (i) Most candidates gained full credit. The most common errors were to give the name of the light emitting diode merely as diode or state that it was a light dependent resistor.

(ii) Stronger candidates were able to identify the correct relationship between the temperature of the thermistor and its resistance. However they often stated what then happened to the p.d./current/brightness etc. incorrectly or were too vague. Answers needed to be specific and to refer to the change of various quantities in a circuit. Many vague resistance/current statements were seen without a link with the correct component. Quantities needed be attributed to a clearly identified component or part of the circuit.

(b) Most candidates answered this well.

Question 10

(a) (i) The majority of candidates recognised that the magnetic field direction was clockwise.

(ii) This question was usually answered well but a number of candidates incorrectly referred to an unqualified magnetic force.

(b) (i) This was answered well and many candidates gained maximum credit giving clear, logical step-by step explanations of what happened. The weaker candidates confused the concepts of electromagnetism and electromagnetic induction and talked, for instance, about the bolt cutting field lines

(ii) Most candidates gave partially correct answers. Weaker candidates failed to state either that the bolt was no longer magnetised or that the bolt now returned to its original position.

Question 11

(a) The majority of candidates could balance both the nucleon and proton numbers but some inverted the notation for the beta particle.

(b) (i) The majority of candidates recognised that the readings on the detector were as a result of background radiation, but a significant number then failed to state the name of one correct source of this radiation.

(ii) Many candidates recognised that the variation in the readings was a result of the random nature of nuclear decay. Others used vague words such as variations, fluctuations etc., which repeated information in the question.

(iii) Many candidates understood that 2 half-lives were involved leading to division by 4 but failed to take account of the need for subtracting the background count or adding it onto the result of the division. Consequently 121.75 was a common, incorrect final answer.

Very few candidates carried out all three steps of this question correctly.

PHYSICS

Paper 0625/43
Paper 4 Extended

Key messages

- Candidates should ensure that information in their responses does not contradict content and invalidate correct answers.
- When a calculation leads to a numerical answer the answer is expected, where appropriate, to include the correct unit and candidates should be made aware that full credit cannot be awarded when the unit is omitted.
- Candidates should also ensure they give their answers to two significant figures.

General comments

Almost all candidates were able to complete the question paper in the time allocated. Candidates need to be familiar with the all topics on the syllabus as extended papers assess the entire syllabus. For candidates to have the best opportunities on the paper they need to have studied each topic and to be equally confident in dealing with the different sections of the syllabus.

When performing a calculation, there were sources of error that appeared repeatedly. Equations with three terms such as $v = f\lambda$ were very commonly rearranged inaccurately to give, for example, the incorrect $\lambda = f / v$. This particular equation seemed more prone to this than equations that do not include Greek letters. There were also candidates who when writing this equation, used the unusual symbol *w* to represent wavelength but who also included the symbol λ. Some candidates entered numbers in standard form into a calculator in such a way that the number was ten times larger than the intended value and this may have resulted in a power-of-ten error in the final answer. Division by numbers that in standard form include a negative index also caused a problem for some candidates.

Comments on specific questions

Question 1

(a) (i) A significant number of candidates simply multiplied the final velocity by the time taken and obtained an answer that was twice the correct value. A very small number of candidates sketched a velocity-time graph and calculated the area underneath the line. This generally produced the correct answer.

(ii) This question was well answered with many candidates obtaining full credit. Occasionally, the answer from **(i)** was used as the acceleration in $F = ma$ or used in an incorrect equation relating force to the distance travelled.

(b) Many candidates did not realise that a resistive force was the focus of this question and were awarded no credit. A common approach was to suggest that an increasing speed required an increasing resultant force and Newton's second law of motion was not considered.

Question 2

(a) This was correctly answered very often and full credit was awarded to many candidates. Errors in unit conversion led to many other candidates obtaining an answer that had the correct significant figures but was too large or too small by factors of ten. Occasionally, the formula that defines density was not remembered correctly or was badly rearranged.

(b) (i) This was very frequently awarded full credit but since there was no need here to covert the units given in the question to base units, numerical errors of factors of ten usually indicated an omitted *g* rather than an arithmetic error. This, of course, is incorrect physics.

(ii) This was correctly answered by only a minority of candidates. Those who did not realise that the pressure from **(i)** did not include atmospheric pressure, produced other explanations that were not usually correct and did not answer the question.

(c) (i) This was usually answered correctly. Many, but not all, of the candidates who used the terms “heavier” or “lighter” eventually made it clear that they were referring in an imprecise manner to density rather than to mass or to weight.

(ii) Although this was usually answered correctly, some answers were too brief to be credited. Some candidates referred to the difference in height between two readings but since the question distinguishes between height and the volume reading, this was not accepted.

Question 3

(a) (i) The correct term was only given by stronger candidates. An incorrect answer seen fairly often was “radiation” which suggested a misunderstanding of the question. Another incorrect answer given was “combustion” which suggested that the Sun is powered by a chemical reaction.

(ii) This was not well answered with many candidates describing nuclear fission reactions or even the combustion of carbon or of other fuels. Very few candidates suggested that some form of particle combination was taking place and of those who did, only a minority referred to nuclei in any way. In some cases, the formation of stars was described.

(b) Many candidates were able to name an appropriate energy source but geothermal and nuclear energy were suggested by some weaker candidates. Most candidates were able to state whether the chosen energy source was renewable but an explanation was not always given.

(c) Most candidates were able to give at least one or two appropriate answers and many candidates gave three or four. When the issue of cost was given, it was necessary to distinguish between the installation cost and the running cost and this was not always done.

Question 4

(a) Most candidates were able to state one other difference between the molecular structure of a solid and that of a liquid. Answers that only referred to the difference already stated or that discussed the macroscopic behaviour of solids and liquids or that were not related to a structural difference could not be credited.

(b) (i) Only the strongest candidates realised that the initial decrease in the liquid level was due to the expansion of the glass.

(ii) Generally, this question was slightly better answered than **(i)** but many of the candidates who had already suggested that the increase in temperature of the liquid led to its contraction felt the need to be consistent and gave answers in terms of a decreasing temperature.

Question 5

(a) This quantity was very often correctly defined although occasionally the specific heat capacity was defined instead. A few candidates stated that the heat capacity is the energy required to reach the melting point. The overwhelming majority of candidates gave answers in terms of energy.

(b) (i) This was very often answered well but some candidates simply supplied 78 J or 78 °C or performed a slightly more complicated calculation than was needed.

(ii) This question proved challenging for many candidates with suggestions that the internal energy was the energy of a single atom. The words *kinetic*, *potential* or *total* were not frequently seen.

(c) Most graphs were essentially correct and were awarded full or nearly full credit. Where full credit was not obtained, this was usually because of an imprecise line. Common inaccuracies included lines that did not start at 100 °C, lines that levelled out at a temperature that clearly was too high or too low and lines whose gradients were constant.

Question 6

(a) (i) In the majority of cases, the correct box was ticked with the most frequent error being the ticking of the box next to 3.0×10^2. This suggests that some candidates thought in terms of the speed of sound in air.

(ii) This was frequently well answered although some rearrangements of the equation gave the reciprocal of the expected value or even the product of the speed and frequency.

(b) (i) **1.** This was only occasionally answered correctly. Some answers suggested that the units that cancelled were degrees (from the angles).

2. This part was very commonly correct in absolute terms or because an error in **(a)(i)** was carried forward. The unit of the final answer was omitted here by some candidates who did not omit units anywhere else in the paper. There were also candidates who multiplied the answer in **(a)(i)** by the refractive index to obtain a value greater than the speed of light in a vacuum.

(ii) Most candidates were awarded some credit here but only a small number were awarded full credit. Some answers were not about the use of optical fibres in communication technology. The endoscope was seen in some answers.

Question 7

(a) (i) Many candidates knew what was expected in this question and produced answers that were awarded full credit. Occasionally an otherwise correct diagram was very poorly drawn with rays that were not straight or rays that very clearly did not pass through the optical centre or a principal focus. There was also a minority of candidates who drew lines from the top of the object which had no significance and which could not be used to locate the image.

(ii) Most candidates underlined the three correct terms with the most common error being the underlining of *virtual* rather than *real*. The distinction between these two types of image was not always fully understood.

(b) Many candidates answered this question correctly. However common errors included: using the original path through the glass and restricting dispersion to the emergent ray; drawing a path that would have been acceptable for red or orange light; drawing the emergent ray parallel to the one already given.

Question 8

(a) Many answers were awarded some credit but full credit was only awarded to the strongest candidates. The majority of candidates stated that the sphere would become positively charged and many stated that the positive charges from the rod would transfer to the sphere. Even when charging was described in terms of moving electrons, the movement of the positive charges was often also described. Many candidates connected the wire to earth and did not state that it needed to be touched against the sphere. This area was not well understood.

(b) This was awarded full credit quite often but many candidates supplied other electric field patterns that were not correct. Circular field lines and field lines that could be used to describe the magnetic field of a bar magnet were commonly drawn. A few diagrams were so poorly drawn that the field lines could not accurately be described as straight and full credit was not awarded.

(c) Most candidates answered this question correctly. There were, however, candidates who left the time in minutes or who rearranged $Q = It$ incorrectly to give $I = Qt$. This usually led to an incorrect numerical final answer.

Question 9

(a) (i) This was generally answered well but a common error was to sketch only one complete cycle. The occasional straight line or very poorly sketched sine or cosine curve was given.

(ii) Point A was often marked at the peak of the curve than at the correct position.

(b) (i) Some candidates realised exactly what was happening here and very succinctly gave an answer that was awarded full credit. More often, candidates made a few vague statements about the magnetic field and were not clear about where the electromagnetic induction was taking place. Candidates confused words such as *coil* and *core*.

(ii) The diode was very commonly correctly identified and its effect was also widely understood. It was not, however, a light-emitting diode.

Question 10

(a) Very few candidates used the expression *electromagnetic radiation* or anything similar and so very few candidates gained credit in this question. Most candidates gave answers in terms of the properties of γ-rays that compared them to α-particles and β-particles rather than stating their nature.

(b) (i)(ii) These two parts were very often correct although a few candidates gave answers consistent with the emission of β-particles or more rarely α-particles. A very small number of answers did not relate to any usual nuclear decay.

(c) (i) This was usually well answered.

(ii) The majority of candidates ignored the effect of background radiation and determined a half-life of 9.0 hours. Only a few candidates were awarded full credit. A common error when calculating a half-life was to count inclusively and to assume that a decay such as 96 to 48 to 24 to 12 counts/minute represents four half-lives because four figures were being quoted.

(d) In general, this was not well answered although many candidates did supply one correct suggestion. Answers tended to be vague and lacking in detail. For example, a number of candidates gave "*wear a radiation-proof suit"* which was not sufficiently clear. Also, the answer "*do not ingest the radioactive sample"* could not be accepted as it is not a safety precaution.

PHYSICS

Paper 0625/51
Practical Test

Key messages

- Candidates need to have had a thorough grounding in practical work, including reflection and discussion on the precautions taken to improve reliability and control of variables.
- Candidates should be aware that, as this paper tests an understanding of experimental work, explanations and justifications will need to be based on practical rather than theoretical considerations.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable.
- Candidates should 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
- planning investigations.

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 were able to draw on their experience of carrying out practical work.

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

Comments on specific questions

Question 1

(a) Most candidates recorded a valid distance *a*.

(b) Many candidates calculated the values correctly but some gave the answers to only 1 significant figure.

(c) Most candidates labelled the graph axes correctly and drew them the right way round. Plotting was generally accurate but some candidates made their plots too large. Many candidates drew a well-judged straight line although some drew a 'dot-to-dot' line whilst others drew a straight line that did not match the plots and these could not be credited.

(d) Candidates needed to show on the graph, as instructed in the question, that they had used a large triangle.

(e) Candidates who had carried out the experiment with care usually obtained a value of *P* that was within the permitted tolerance.

Question 2

(a) Most candidates read the meters correctly and gave V_1 to at least 1 decimal place and I_1 to at least 2 decimal places. Most candidates also calculated R_1 correctly.

(b) Here credit was awarded for recording new values of V and I and obtaining a value of R_2 within the tolerance allowed.

(c) In **(i)** the new value of I had to be less than I_2 in order to be credited, showing that the circuit had manipulated correctly. In **(ii)** credit was awarded to those candidates who had shown correct use of the units A, V and Ω within the question, without any contradiction.

(d) Candidates needed to make a decision about their agreement or otherwise with the suggestion. Credit was awarded to those candidates who justified their decision clearly, indicating that they understood the concept of judging results to be the same if they were within the limits of experimental accuracy.

(e) Many answers to this question were too vague. Candidates were expected to explain briefly that current and voltage readings for each resistor in turn could be used.

(f) Candidates were expected to complete the circuit diagram as instructed including one voltmeter connected across the three resistors in parallel. A significant number of candidates drew a thermistor in place of the variable resistor.

(g) Candidates needed to recognise that to determine the combined resistance it would be good practice to repeat the experiment with different currents. The variable resistor would be used in order to do this. Weaker answers stated, "To vary the current" without a reason which was not sufficient to gain credit.

Question 3

(a) & (b) The majority of candidates recorded valid distances and calculated *uv* correctly. Some, however, recorded distances that could not have produced a focused image on the screen.

(c) Most candidates realised that the images would differ in size.

(d) Most candidates carried out the calculations of f_1 and f_2 correctly. Some candidates did not know how to calculate the average focal length value. Partial credit was awarded for values given to 2 or 3 significant figures. Credit was given to candidates who had correctly used their figures in the table even if those had been wrongly recorded or calculated.

(e) Candidates were expected to assume that the apparatus was set up sensibly. For example, with a sufficiently bright object and a suitably dimly lit room. From their own experience of lens experiments during their study they should have been aware of the reasons for the difficulty in obtaining reliable results. For example, the difficulty in deciding the exact position of the screen that produces the sharpest image.

Question 4

Many candidates coped well with this planning question. Successful candidates were able to write a brief, logical account, using the guidelines given. Many candidates sensibly set out their answer in clear sections following the order of the bulleted points in the question.

Most candidates realised that a stopwatch was required but fewer also included a rule to measure the length of the pendulum.

Recording the time for at least 5 oscillations was required and then dividing the time by the number of oscillations to calculate the period. This must then be repeated with the each of the pendulum bobs in turn.

There are several variables to control and credit was given for one correct response. The most obvious was the length of the pendulum and many candidates identified this.

The table headings needed to match the method and to be shown clearly with the correct units. The minimum requirement was columns for diameter of pendulum bob and time.

Many candidates found it difficult to express how they reached a conclusion. Credit was given to candidates who suggested a graph of time against diameter or a comparison of times with the different diameters. Some candidates made a prediction, which was not asked for in the question. Candidates need to be taught to read the question very carefully and to think clearly about what is being asked before beginning to write.

PHYSICS

Paper 0625/52
Practical Test

Key messages

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

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

General comments

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

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

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

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

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

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

There were instances this year of centres not supplying the correct apparatus. Where this was not mentioned in the report from the Supervisor, it was difficult to award credit. It is important to provide details of changes made to the specified apparatus, and possibly specimen results if appropriate, so that appropriate credit to candidates' results that lie outside the expected tolerance values can be given.

Comments on specific questions

Question 1

(a) Many candidates found this question challenging. Only the strongest candidates could explain clearly how they used the set-square provided to avoid a parallax error when measuring the distance from the clamp to the bottom of the pendulum bob. Those candidates who took the prompt given in the question, and drew a diagram to help their explanation, answered far better that those who tried to explain using words only. A large number of the written answers did not mention the use of a ruler. Rulers were also frequently missing from the answers of those candidates who had chosen to draw a diagram. The idea that the set-square provides a horizontal reference point from the level of the bottom of the bob to the reading on the rule was rarely included in answers.

(b) The time for 20 oscillations of the pendulum was almost always recorded and was within the timing tolerance allowed. The period of the pendulum was usually calculated correctly, although occasionally no units were given.

(c) As in **(b)**, the time for 20 oscillations, and the period of the second pendulum were recorded, and in most cases this second period was less than the previous period, as it should have been. A number of candidates quoted the period to more than three significant figures however.

(d) Most candidates were able to state whether or not their results supported the statement given. Far fewer candidates were able to give a convincing justification for their statements. The idea of experimental tolerances and whether two measured quantities are close enough to be considered equal was not well understood by the majority of candidates.

(e) Approximately half the candidates selected the correct explanation in this question. A very popular incorrect choice was that timing twenty oscillations involves more readings and so there is less chance of errors.

(f) Many candidates did not understand the instruction given, which was that a letter P or a letter V should be placed in each of the six given boxes to say whether the statement was a precaution (P) or a variable (V). In a significant number of answers, only two of the six boxes were chosen and a letter P written in one and a letter V in the other.

Question 2

(a) Most candidates recorded θ_R, the room temperature, and the value given was a sensible one.

(b) The instructions were almost always followed correctly and nearly all candidates recorded three temperatures in the spaces provided.

(c) Many candidates gave a sensible suggestion as to why the water in the beaker containing the mixture of hot and cold water was stirred before the final temperature of the mixture was taken. The most popular answer was to make sure that the temperature of the mixture was the same throughout the beaker. Many candidates just stated that the stirring was to mix the water but made no reference to temperature.

(d) & (e) The procedure carried out in **(b)** was successfully repeated with the two different volumes of water by all candidates.

(f) Most candidates measured the temperature of the room again, compared it with the temperature they had obtained at the start of the experiment, and ticked the appropriate box. However, despite the instruction given, a sizeable minority of candidates ticked all three boxes.

(g) Only the stronger candidates were able to suggest why the temperature fall of the hot water was not the same in all three experiments. Despite taking and recording the temperature readings, they did not notice that the initial temperatures of the cold/hot water were not the same. Of those candidates who obtained credit here, the most frequently seen answer was that the differences arose due to heat losses to the surroundings.

(h) Any answer that made reference to insulation/lagging or the use of a lid was given credit here.

(i) Most candidates were able to suggest a correct control variable. The most popular correct answers were to maintain a constant room temperature or to ensure that the initial temperature of the hot/cold water was the same.

Question 3

(a) All candidates followed the instruction given and recorded the value of object distances *u* and the measured value of the image distances *v* in the table provided. Very occasionally the values of *v* increased instead of decreased as the object distance *u* increased. Sometimes the values of the image distances were not quoted to a consistent number of significant figures and could not be credited.

(b) The standard of graph plotting was not strong in this question. Candidates nearly always chose horizontal and vertical scales that did not make use of at least half of the given grid, despite the instruction given in the question that candidates did not need to start their axes at the origin. There was some evidence of the use of scales that increased in inconvenient increments, such as 3 or 7. Choosing such scales makes the points much harder to plot by the candidates.

There were many excellent, carefully drawn, smooth curves produced by candidates. However there were many graphs where the points were joined dot-to-dot, and best-fit lines were attempted, despite the instruction to draw a curve. Many candidates drew a straight line, when the evidence of the plots was overwhelmingly a curve. The concept of best-fit was clearly not well understood by all candidates.

(c) Most candidates followed the instruction given, plotted the two points, and joined these points with a straight line. The coordinates of the point where their straight line crossed the curve were usually read and recorded directly, but in some cases, careless reading of the scales on the axes resulted in incorrect results. Candidates are allowed a tolerance of to within ± 1 small square on the graph grid.

The focal length of the lens was usually calculated correctly. In most cases, the value of the focal length obtained was close to the value recorded by the supervisor.

Question 4

Although it was not a requirement to draw a diagram in this planning question, many candidates did this and used the diagram to aid their explanation. Carefully drawn diagrams could be awarded credit. However most were rough sketches drawn without the aid of a ruler.

Many candidates did not state that they would begin by measuring the length of the selected rubber band. In many cases candidates assumed that the length was known. The general procedure was well understood with candidates hanging a load on the elastic band and measuring its new length. Many candidates had no idea of the loads that would produce reasonable extensions with a rubber band. The range of masses used by candidates to stretch their bands ranged from 1 g to 50 kg.

Having loaded their elastic band and measured the extension, candidates were expected to choose a rubber band of different thickness and repeat the procedure. This essential part of the investigation was frequently missing from answers. A minority of candidates missed the point of the investigation completely and repeated their procedure with another rubber band of the same thickness but of different length.

Most candidates appreciated that to make the investigation a fair test, equal lengths of elastic bands should be taken for each part of the investigation. The idea that the same load/range of loads or the same type/material of rubber band should be used each time was stated far less frequently.

Despite the instruction given to candidates to draw a table with headings, tables were often missing. The headings in many tables given by candidates did not relate to the given investigation. Where suitable tables were drawn, there were often no units in the column headings.

Only the strongest candidates were successful in explaining how they would use their readings to reach a conclusion. Most candidates knew intuitively that the thicker the elastic band, the less it would stretch (for the same load), and merely stated so. Stronger candidates stated that they would use their results to plot a graph of extension against thickness (for the same load) or to plot graphs of load against extension for different thickness of elastic band.

PHYSICS

Paper 0625/53
Practical Test

Key messages

- Candidates need to have a thorough grounding in practical work, including reflection on the precautions taken to improve reliability and control of variables. Candidates should be ready to apply their practical knowledge in planning and designing an experiment to investigate a given brief. As this investigation may be able to be based on a standard experiment it is important for candidates to have a wide experience of practical work

- Candidates should be aware that, as this paper tests an understanding of practical work, explanations will need to be based on data from the question or the implications of observations rather than theoretical considerations.

- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. Use of the recurring symbol should be avoided as it does not allow the appropriate number of significant figures to be indicated.

- Candidates should be reminded that any drawing or graphical work should be done carefully.

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 and justifying conclusions
- dealing with possible sources of error
- controlling variables
- making accurate measurement.

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.

Candidates who had experience of similar practical work answered questions on experimental techniques effectively. The quality of the results obtained in **Questions 1**, **2** and **3** was a reflection of the candidates' experience of experimental work.

Where explanations or justifications were required, candidates needed to base them on practical considerations, using data obtained during the experimental work. Theoretical responses were not usually adequate, particularly when reference to results was asked for. Good use of values to support explanation or justification was seen in answers to **Questions 1(d)(i)** and **2(b)(iv)**. Clear detail was used in a number of the answers to Questions **1(d)(ii)** and **3(a)(ii)**.

Some weaker responses indicated that candidates had not read the specific requirements of the questions carefully.

Where answers were supported by drawings, these needed to be clear and large enough to be easily interpreted. Any graphical work needed to be carried out using a sharp pencil and, where straight lines were needed, a ruler. Some very clear diagrams were seen in responses to **Questions 2(d)**, **3(a)(ii)** and **4** as well as good graphical skills in **Question 3(b)**.

In questions requiring an outline of an investigation candidates need to read the question carefully and apply logical application of good experimental practice. A number of candidates showed good practical knowledge when answering **Question 4** but it was clear that many candidates had not been prepared for this or had limited experience of basic experiments.

Comments on specific questions

Question 1

This question was answered well by many candidates but some found the explanations and justifications challenging.

(a) Most candidates obtained a set of reducing temperature readings although some recorded the room temperature at t = 0.

(b) (i) Many candidates had a set of temperature values reducing more slowly than those in **(a)**.

(ii) Many candidates gained full credit but some left the unit for temperature blank.

(c) The most common correct answers were ensuring that the thermometer was not touching the beaker and reading the scale perpendicularly to avoid parallax. A significant number of candidates referred to conditions, such as constant room temperature, rather than precautions appropriate to reading a thermometer.

(d) (i) Most candidates found and stated that the lid reduced the rate of cooling but many did not use the full temperature range to justify their answer, or purely referred to the difference in their final readings. Not all candidates gave values or referred to the results, often relating theoretical considerations such as convection or evaporation.

(ii) Many candidates took the prompt from the question and suggested that the volume of water should have been the same in both beakers. They were normally able to explain that this also affects the rate of cooling. Having the same starting temperatures was also a common response. A number of candidates did not receive full credit due to lack of detail in their explanations.

(iii) Many candidates were able to recognise that the rate of cooling decreased in their experiments as time went on. However, other candidates spotted other patterns of similarity and limited comparisons were accepted in this more difficult situation.

Question 2

Many candidates did well in this question, showing confidence in obtaining and recording accurate results.

(a) Most candidates were able to show the correct voltmeter symbol connected in parallel across resistor **X**, although there were many who drew a line through the symbol or showed the voltmeter connected in series. This latter situation may have been remedied when physically connecting the circuit as this mistake did not always produce incorrect readings.

(b) (i) Many candidates obtained a sensible value for current, expected to be less than 1.00 A, and expressed it to 2 decimal places with the correct unit.

(ii) This question's answer required a comparison of the two potential differences as well as both quantities being less than 3.0 V and expressed to at least 1 decimal place at least. Only a small number of candidates obtained values which appeared to be reversed.

(iii) Many candidates obtained a potential difference across the combination which was within 10% of the sum of the individual potential differences.

(iv) While many candidates correctly stated that their readings supported the suggestion, a significant number of answers disagreed, failing to recognise that a small difference was acceptable within the limits of experimental accuracy. Contradiction of the statement was expected and given credit if the difference was greater than 10%. The correct justification was seen but a number of candidates did not use the results quantitatively by referring to the values or their difference.

(c) The calculation was usually carried out correctly. However, a number of candidates did not round appropriately, expressed the value to an excessive number of significant figures or failed to give the unit.

(d) Most candidates were credited for showing resistors in parallel. Many were not able to complete the circuit correctly. Some showed ammeters in parallel or short circuited the parallel branch.

(e) This question was an assessment of the overall practical procedure and most candidates showed that they had set up the circuit correctly. In this case, mistakes in drawing the circuit were usually reflected in the values recorded.

Question 3

(a) (i) Most candidates obtained a set of increasing *F* values and expressed them to at least 1 decimal place.

(ii) Using a ruler to check equal distances between rule and bench at both ends and use of a protractor or set square between rule and stand were common responses which gained credit. Some vague responses failed to suggest that measured distances must be equal or showed a set square against part of the apparatus which would not indicate the rule to be horizontal.

(b) Some good graphical skills were seen in many answers and many high-quality graphs were drawn. Most candidates chose a suitable scale and labelled the axes correctly. Only a very few candidates reversed the axes. The most common mistake with the scale was to give the same interval between the origin and 10.0 cm as between 10.0 cm and 30.0 cm. Plotting was generally good. Many candidates indicated the plots with fine crosses. Small dots are acceptable but are often obscured when the line is drawn through them, making it more difficult to see the point. A sharp pencil should be used for the plots and for the line to ensure drawings are accurate. A very small number of candidates gave their data points equal intervals on the *x*-axis, which was incorrect. Most candidates produced a best-fit straight line as clearly indicated by the plots. A few candidates chose to fit a curve, some wrongly but others because their plots clearly suggested it. This latter situation gained credit. The most common incorrect response was to join points together.

(c) (i) Most candidates were able to gain credit here with some good reading of the intercept on the *y*-axis.

(ii) Many candidates answered correctly which indicated a combination of accurate graphical work and good interpretation. However, some candidates did not include a unit or gave an unsuitable number of significant figures. Some values were not within range because of poor best-fit lines or forcing the line through the origin giving a weight of 0.0 N for the metre rule.

(d) This question proved challenging for many candidates but stronger candidates were able to answer correctly. Few candidates linked the scatter of their points to the ability to draw a reliable best-fit straight line. Even when plotted points were in a straight line, not all candidates used this as an explanation.

(e) There were a number of valid responses to this question. Many candidates correctly referred to repeating the experiment and taking an average value for the weight. A few suggested taking more readings by using smaller intervals of *d* and a very small number recommended repeating the suspect readings. Precautions for carrying out the experiment carefully could not be credited.

Question 4

Although some good individual responses were seen, this question proved to be the most challenging for many candidates across the ability range, despite being based on a standard practical procedure which should have been recognised from the list of available apparatus. However, most candidates gained some credit with only a few not attempting the question.

Candidates should be reminded to read the instructions carefully. Many wrote about repeats for different lenses when the question called for measurement of only one lens. When candidates recognised the experiment they generally answered well but some candidates who did not recognise it linked it to reflection and ray diagrams. A number of candidates introduced a solid object in front of the lamp and talked about the shadow produced.

There were some very clear answers with a significant amount of good detail. Most of these followed the structure suggested by the question and it was clear from some responses that the bullet points had been used by candidates as a checklist of what was to be included. Many candidates did not suggest use of an additional screen on which to focus the image and some omitted the need for a metre rule.

A number of diagrams were accurate and easy to interpret but some lacked clarity, particularly with a rather vague indication of *u* and *v* distances. Repeating with different *u* distances to obtain a reliable value for focal length gained credit but this was rarely seen. Many candidates indicated that parallax error should be avoided when measuring with the metre rule but few stated how that should be done by viewing the reading perpendicularly. Some correctly suggested clamping the rule to obtain accurate measurements.

PHYSICS

Paper 0625/61
Alternative to Practical

Key messages

Candidates need to have had a thorough grounding in practical work, including reflection and discussion on the precautions taken to improve reliability and control of variables.

Candidates should be aware that as this paper tests an understanding of experimental work, explanations will need to be based on data from the question and practical experience 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 be ready to apply their practical knowledge to unusual situations.

Candidates should be reminded to read questions carefully to ensure that answers given address the question exactly as it has been asked.

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
making accurate measurements
choosing the most suitable apparatus
planning an investigation.

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. Some of the skills involved in experimental work, including graph plotting and tabulation of readings, can be practised without doing experiments. However, there are parts of this examination in which the candidates are asked to answer from their own practical experience.

Questions on experimental techniques were answered much more effectively by candidates who clearly had experience of similar practical work.

The practical nature of the examination should be kept in mind when explanations, justifications or further developments are asked for. This was particularly relevant in **Questions 1(e)**, **(f)** and **(g)**, **2(c)**, **(e)** and **(f)**, and **4(e)**.

Comments on specific questions

Question 1

(a) The majority of candidates read the meters correctly although some did not work out the value of each division and answered, for example, 1.4 V for V_1. Most calculated R_1 correctly.

(b) In this question the answer needed to be given to 2 or 3 significant figures.

(c) Many candidates drew the pointer with care so that there was no doubt about the exact position. A minority of candidates showed a wrong reading.

(d) Candidates needed to make a decision about their agreement or otherwise with the suggestion. The figures were such that the statement could be 'Yes' or 'No'. Credit was awarded to those candidates who justified their decision clearly, indicating that they understood the concept of judging results to be the same if they were within the limits of experimental accuracy. Weaker candidates who did not demonstrate understanding sometimes gave answers such as "must include the idea of within (or beyond) the limits of experimental accuracy" and could not be awarded credit.

(e) Many responses were too vague for credit. Candidates were expected to explain briefly that current and voltage readings for each resistor in turn could be used.

(f) Candidates were expected to complete the circuit diagram as instructed including one voltmeter connected across the three resistors in parallel. A significant number of candidates drew a thermistor in place of the variable resistor.

(g) Candidates were expected to realise that to determine the combined resistance it would be good practice to repeat the experiment with different currents. The variable resistor would be used in order to do this. Answers stating "to vary the current" without a reason were not sufficient.

Question 2

(a) The majority of candidates recorded the distances correctly with the appropriate unit.

(b) While many candidates answered successfully, some candidates divided by 10 instead of multiplying and others wrote answers that were difficult to relate to their values of v and d.

(c) Most candidates realised that the images would differ in size.

(d) Most candidates carried out the calculations of f_1 and f_2 correctly. Some candidates did not know how to calculate the average focal length value. Credit was awarded for values given to 2 or 3 significant figures. Credit was also given to candidates who had correctly used their figures in the table even if they had been wrongly calculated.

(e) Candidates were expected to assume that the apparatus was set up sensibly. For example, with a sufficiently bright object and a suitably dimly lit room. From their own experience of lens experiments they should be aware of the reasons for the difficulty in obtaining reliable results. For example, the difficulty in deciding the exact position of the screen that produces the sharpest image.

(f) This item gave another opportunity for candidates to write from their own experience of practical work. Those who could recall their experience were able to make sensible suggestions.

Question 3

Many candidates coped well with this planning question. Successful candidates were able to write a brief, logical account, using the guidelines given. Many candidates sensibly set out their answers in clear sections following the order of the bulleted points in the question.

Most candidates realised that a stopwatch was required but fewer also included a rule to measure the length of the pendulum.

Recording the time for at least 5 oscillations was required and then dividing the time by the number of oscillations to calculate the period. This then needed to be repeated with the each of the pendulum bobs in turn.

There were several variables to control and credit was given for one correct response. The most obvious was the length of the pendulum and many candidates identified this.

The table headings needed to match the method and be shown clearly with the correct units. The minimum requirement was columns for diameter of pendulum bob and time.

Many candidates found it difficult to express how they reached a conclusion. Credit was given to candidates who suggested a graph of time against diameter or a comparison of times with the different diameters. Some candidates made a prediction which was not asked for in the question. Candidates need to be taught to read the question very carefully and think clearly about what is being asked before beginning to write.

Question 4

(a) Many candidates calculated the values correctly but some only gave the answers to only 1 significant figure.

(b) Most candidates labelled the graph axes correctly and drew them the right way round. Plotting was generally accurate but some plots were too large. Many candidates drew a well-judged straight line although some drew a ‘dot-to-dot’ line whilst others drew a straight line that did not match the plots.

(c) Candidates needed to show that they had used a large triangle on the graph as instructed in the question. Many candidates obtained a value of P that was within the permitted tolerance.

(d) A significant number of candidates did not study the scale with sufficient care and so gave an incorrect value for P.

(e) All candidates should have had experience of this type of experiment using a balancing method with a metre rule and using a force meter. However only a minority of candidates answered this correctly, drawing on their experience.

PHYSICS

Paper 0625/62
Alternative to Practical

Key messages

Candidates should be given the opportunity to develop a thorough grounding in 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.

General comments

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

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

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

The vast majority of candidates completed all questions the paper. There were some candidates who showed an excellent understanding of practical skills but equally, there were those who 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) Only the strongest candidates quoted the value of *d* they had measured to an appropriate degree of accuracy. The measured length of *d* was exactly 5 cm, and as candidates were using a ruler graduated in millimetres, an answer of 5.0 cm was expected. The majority of candidates wrote 5 cm and could not be credited. The actual distance *D* was usually deduced correctly from the scale factor supplied in the question. A small percentage of candidates divided their values of *d* by 10 instead of multiplying by 10.

In the first part of the question few candidates could explain clearly how they used the set-square provided to avoid a parallax error when measuring the distance from the clamp to the bottom of the pendulum bob. Those candidates who took the prompt given in the question, and drew a diagram to help their explanation, answered far better that those who tried to explain using words only. A large number of the written answers did not mention the use of a ruler. Rulers were also frequently missing from the answers of those candidates who had chosen to draw a diagram. The idea that the set-square provides a horizontal reference point from the level of the bottom of the bob to the reading on the rule was rarely included in answers.

(b) Most candidates read the value of time from the stopwatch correctly and calculated the correct period of the pendulum. Where errors were made, it was because of a failure to include a unit with the answer or recording the time registered by the stopwatch in minutes instead of seconds.

(c) Most candidates were able to state, whether or not, the results supported the statement given. Far fewer candidates were able to give a convincing justification for their statements. The idea of experimental tolerances and whether two measured quantities are close enough to be considered equal was not well understood by the majority of candidates.

(d) Candidates were given four possible explanations about why it is better experimental practice to time 20 oscillations of the pendulum and then calculate the period, rather than just time one oscillation. Approximately half the candidates placed a tick opposite the correct explanation. Of those candidates who did not, a common incorrect choice was that timing twenty oscillations involves more readings and so there is less chance of errors.

(e) Many candidates did not understand the instruction given, that a letter P or a letter V should be placed in each of the six given boxes to say whether the statement was a precaution (P) or a variable (V). In a significant number of answers, only two of the six boxes were chosen and the letter P written in one and the letter V in the other.

Question 2

(a) Almost all candidates recorded the reading shown on the thermometer correctly. Where mistakes were made, the most common incorrect answers were 20.4°C and 36°C.

(b) The calculation of the fall in temperature of the hot water was almost always done correctly.

(c) The calculation of the new temperature fall of the water was almost always done correctly.

(d) Approximately half of the candidates gave a sensible suggestion as to why the water in the beaker containing the mixture of hot and cold water was stirred before the final temperature of the mixture was taken. The most common answer was to make sure that the temperature of the mixture was the same throughout the beaker. Many candidates merely stated that the stirring was to mix the water but made no reference to temperature.

(e) Only the stronger candidates were able to suggest why the temperature fall of the hot water was not the same in all three experiments. Despite taking and recording the temperature readings, they did not notice that the initial temperatures of the cold/hot water were not the same. Of those candidates who obtained credit here, the most popular answer was that the differences arose due to heat losses to the surroundings.

(f) Any answer that made reference to insulation/lagging or the use of a lid was given credit here.

(g) A majority of candidates were able to suggest a correct control variable. The most common correct answers were to maintain a constant room temperature or to ensure that the initial temperature of the hot/cold water was the same.

(h) The use of a measuring cylinder to measure a given volume of water was well understood. The majority of diagrams drawn by candidates were drawn well and showed perpendicular viewing at the water surface and to the bottom of the meniscus. However a number of candidates drew a beaker instead of a measuring cylinder.

Question 3

(a) The standard of graph plotting was not strong in this question. Candidates nearly always chose horizontal and vertical scales that did not make use of at least half of the given grid, despite the instruction given in the question that candidates did not need to start their axes at the origin. There was little evidence of the use of scales that increased in inconvenient increments, such as 3 or 7. Choosing such scales makes the points much harder to plot.

There were many excellent, carefully drawn, smooth curves produced by candidates. However there were many graphs where the points were joined dot-to-dot, and best-fit lines were attempted, despite the instruction to draw a curve. Many candidates drew a straight line, when the evidence of the plots was overwhelmingly a curve. The concept of best-fit was well understood by all candidates.

(b) Most candidates followed the instruction given, plotted the two points, and joined these points with a straight line. The coordinates of the point where their straight line crossed the curve were usually read and recorded directly, but in some cases, careless reading of the scales on the axes resulted in errors. Candidates were allowed a tolerance of to within ±1 small square on the graph grid.

The focal length of the lens was usually calculated correctly. In most cases, the value of the focal length obtained was within the tolerance allowed.

(c) Most candidates were able to give at least one correct difference between the illuminated object and the image on the screen. A minority of candidates stated that the image formed on the screen was virtual. This demonstrated a complete misunderstanding of the properties of a real image.

(d) The precautions to be taken when conducting an experiment to determine the position of the image of an object formed by a converging lens were well known.

Question 4

Although it was not a requirement to draw a diagram in this planning question, many candidates did this and used the diagram to aid their explanation. Carefully drawn diagrams could be awarded credit. However most were rough sketches drawn without the aid of a ruler.

Many candidates did not state that they would begin by measuring the length of the selected rubber band. In many cases candidates assumed that the length was known. The general procedure was well understood with candidates hanging a load on the elastic band and measuring its new length. Many candidates had no idea of the order of magnitude of the loads that would produce reasonable extensions with a rubber band. The range of masses used by candidates to stretch their bands ranged from 1 g to 50 kg.

Having loaded their elastic band and measured the extension, candidates were expected to choose a rubber band of different thickness and repeat the procedure. This essential part of the investigation was frequently missing from answers. A minority of candidates missed the point of the investigation completely and repeated their procedure with another rubber band of the same thickness but of different length.

Most candidates appreciated that to make the investigation a fair test, equal lengths of elastic bands should be taken for each part of the investigation. The idea that the same load/range of loads or the same type/material of rubber band should be used each time was stated far less frequently.

Despite the instruction given to candidates to draw a table with headings, tables were often missing. The headings in many tables given by candidates did not relate to the given investigation. Where suitable tables were drawn, there were often no units in the column headings.

Only the strongest candidates were successful in explaining how they would use their readings to reach a conclusion. Most candidates knew intuitively that the thicker the elastic band, the less it would stretch (for the same load), and merely stated so. Better candidates stated that they would use their results to plot a graph of extension against thickness (for the same load) or to plot graphs of load against extension for different thickness of elastic band.

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Key messages

- Candidates need a thorough grounding in practical work, including reflection on the precautions taken to improve reliability and control of variables.
- Explanations should be detailed and support responses to questions. They will need to be based on data from the question and 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.
- Any drawing or graphical work should be done carefully.
- Candidates should be ready to apply their practical knowledge in planning and designing an experiment to investigate a given brief. As this investigation may be based on a standard experiment it is important for candidates to have wide experience of practical work.

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 and justifying conclusions
- dealing with possible sources of error
- controlling variables
- making accurate measurement
- 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. Some of the skills involved in experimental work, including graph plotting and tabulation of readings, can be practised without doing experiments. However, there are parts of this examination in which the candidates are asked to answer from their own practical experience.

Questions on experimental techniques were answered very much more effectively by candidates who clearly had experience of practical work. This was evident in the clear practical details given by some candidates in **Questions 1**, **3** and **4**.

Where explanations or justifications are required, candidates should base them on practical considerations, using data from the question. Theoretical responses are not usually adequate, particularly when reference to results is asked for. Good use of values to support explanation or justification was seen in answers to **Questions 1(c)(i)**, **2(c)(iii)** and **2(e)(ii)**. Clear detail was used in a number of the answers to **Questions 1(c)(ii), 1(d)(ii) and 3(d).**

It is expected that numerical answers will include a matching unit and will be correctly rounded to a number of significant figures which is appropriate to the data given in the question. These points were demonstrated in many of the responses to **Questions 2(d)** and **3(c)(ii)**.

The use of the recurring symbol should be avoided as it does not allow the appropriate number of significant figures to be indicated.

Where answers were supported by drawings, these needed to be clear and large enough to be easily interpreted. Any graphical work needed to be carried out using a sharp pencil and, where straight lines were needed, a ruler. Some very clear diagrams were seen in responses to **Questions 2(e)(i)**, **3(a)(ii)** and **4** as well as good graphical skills in **Question 3(b)**.

There will be questions in which candidates will be asked to outline a plan for an investigation. These questions required careful reading of the question and the logical application of good experimental practice. A number of candidates showed good practical knowledge when answering **Question 4** but it was clear that many candidates had not been prepared for this or had limited experience of basic experiments.

<u>Comments on specific questions</u>

Question 1

This question was answered well by many candidates but some found the explanations and suggestions challenging.

(a) Many candidates gained full credit but a number of candidates left the unit for temperature blank or failed to appreciate that the time column started at 0.

(b) The most common correct answers ensured that the thermometer was not touching the beaker and read the scale perpendicularly to avoid parallax. A significant number of candidates referred to conditions, such as constant room temperature, rather than precautions appropriate to reading a thermometer.

(c) (i) Most candidates were able to state that the lid reduced the rate of cooling but many did not use the full temperature range to justify their answer, or only referred to the difference in the final readings neglecting the fact that the beakers started at different temperatures. Not all candidates gave values or referred to the results, often relating theoretical considerations such as convection or evaporation.

(ii) Many candidates took the prompt from the question and suggested that the volume of water should be the same in both beakers. They were normally able to explain that this also affects the rate of cooling. Having the same starting temperatures was also a common response. A number of candidates however, did not give sufficient detail in their explanations.

(iii) Many candidates were able to recognise that the rate of cooling decreased as time went on. However, the word “pattern” was not interpreted correctly by many candidates who compared individual readings or gave differences rather than similarities.

(d) (i) Almost all candidates could state the correct temperature. A small number gave responses such as 20.3 rather than 23.

(ii) A few concise answers were seen relating the smaller temperature difference to a reduction in transfer of thermal energy and a subsequent reduction in cooling rate. Many candidates failed to give a valid suggestion and explanation, some indicating that the cooling rate would be affected but not clarifying how or why.

Question 2

Candidates across the ability range answered this question well.

(a) Most candidates were able to show the correct voltmeter symbol connected in parallel across resistor **X**, although there were a significant number who connected it in series or carelessly drew a line through the symbol.

(b) Almost all candidates were able to give the correct reading. However, the incorrect value of 0.19 A was also seen. A small number of candidates forgot to give the units required.

(c) (i) Most candidates were able to give the correct readings.

(ii) The correct use of units for current and potential difference was the focus of this question. Units were mostly correct but some candidates failed to include a unit. Only a very small number of candidates gave an incorrect unit.

(iii) Many candidates correctly stated that the readings supported the suggestion but some candidates disagreed, failing to appreciate that 0.2V was a difference within the limits of experimental accuracy. The correct justification was seen but a number of candidates did not use the results quantitatively by referring to the values or their difference.

(d) The calculation was usually carried out correctly. However a number of candidates did not round appropriately, giving the value as 20.5, or failed to give the unit. Use of 20.5 with a recurring symbol above the 5 could not gain full credit as it is not possible to tell how many significant figures were intended.

(e) (i) Most candidates were credited for showing resistors in parallel. Some, however, did not use the correct symbols, despite these having been given in the figure. Many candidates were not able to complete the circuit correctly. Some showed ammeters in parallel or short circuited the parallel branch.

(ii) This part of the question proved to be challenging for many. A number of candidates calculated the resistance in parallel and then compared this with the resistance in series to prove the circuit had been set up correctly. This was the most common explanation achieving credit although the simpler recognition that the current in the parallel circuit was greater than that in the series circuit was also seen. A theoretical justification was often given, without the required reference to the readings, which merely repeated the statement from the question.

Question 3

(a) (i) Most candidates gave the correct answer but a number read the value as 0.55N, misinterpreting the scale of the forcemeter.

(ii) Using a ruler to check equal distances between rule and bench at both ends and use of a protractor or set square between rule and stand were common responses which gained credit. Holding a spirit level close to the metre rule was also acceptable. Some vague responses failed to suggest that measured distances must be equal or showed a set square against part of the apparatus which would not indicate the rule to be horizontal.

(b) Some good graphical skills were seen in many answers and many high-quality graphs were drawn. Most candidates chose a suitable scale and labelled the axes correctly. Only a very few candidates reversed the axes. The most common error seen with the scale was to give the same interval between the origin and 10.0 cm as between 10.0 cm and 30.0 cm

Plotting was generally good. Misreading the scale at 1.5N rather than 1.05N was the most significant source of plotting error. Many candidates indicated the plots with fine crosses. Small dots were acceptable but were often obscured when the line was drawn through them, making them more difficult to identify. A sharp pencil should be used for the plots and for the line so that accurate drawing can be achieved. Most candidates made a good attempt at drawing the best-fit straight line which was clearly indicated by the plots. A few candidates wrongly chose to fit a curve or, more often, joined points together.

(c) (i) Most candidates were able to gain credit here with some good reading of the intercept on the *y*-axis.

(ii) Many candidates showed accurate graphical work and good interpretation in this question. However, only stronger candidates gained full credit as many answers lacked a unit or gave an unsuitable number of significant figures. Some values were not within range because of poor best-fit lines or forcing the line through the origin giving a weight of 0.0N for the metre rule.

(d) This was a challenging question but the stronger candidates were able to answer it well. Few answers linked the scatter of the points to the ability to draw a reliable best-fit straight line.

(e) There were a number of valid responses to this question. Many candidates correctly referred to repeating the experiment and taking an average value for the weight. A few suggested taking more readings by using smaller intervals of *d* and a very small number recommended repeating the suspect readings. Precautions for carrying out the experiment carefully were not given credit.

Question 4

Although some good individual responses were seen, this question proved to be the most challenging for candidates across the ability range, despite being based on a standard practical procedure which should have been recognised from the list of available apparatus. However, most candidates gained at least partial credit with only a few not attempting the question. Candidates are reminded to read all parts of the question carefully. Many spoke about repeats for different lenses when the question called for measurement of only one lens. When candidates understood the experiment they generally answered well but other candidates linked it to reflection and ray diagrams. A number of candidates introduced a solid object in front of the lamp and talked about the shadow produced.

However, there were some very clear answers with a significant amount of good detail. Most of these followed the structure suggested by the question and it was clear from some responses that the bullet points had been used by candidates as a checklist of what was to be included.

Many candidates did not suggest use of an additional screen on which to focus the image and some omitted the need for a metre rule.

The card with the triangular hole, intended to be the object, was sometimes mistakenly used as a screen. If this was addressed in the list of additional apparatus, it was allowed as an error carried forward in the diagram.

A number of diagrams were accurate and easy to interpret but many lacked clarity, particularly with a rather vague indication of *u* and *v* distances.

Repeating with different *u* distances to obtain a reliable value for focal length gained credit but this was only seen in the strongest answers.

Many candidates indicated that parallax error should be avoided when measuring with the metre rule but few stated how that should be done by viewing the reading perpendicularly. Some correctly suggested clamping the rule to obtain accurate measurements