PHYSICS

Paper 0625/11
Multiple Choice (Core)

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

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

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

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

General comments

Candidates demonstrated very good knowledge about determining the position of the centre of gravity, changes of state, good electrical conductors and radiation emitted by the Sun. However, there were some misconceptions about total internal reflection and induced e.m.f. It was evident that seismic waves and radioactive decay were not well understood.

Comments on specific questions

Question 3

Candidates should be familiar with an experiment to determine the density of a liquid. The majority of stronger candidates answered this correctly, but the most common incorrect answers of options **C** and **D** indicated that weaker candidates had not rearranged the density equation correctly and instead they had divided volume by mass. For numerical questions, candidates would benefit from writing down the relevant equation and their calculations to work out the answer before looking at the different options.

Question 7

There was evidence that many candidates, especially weaker candidates, could not recall and combine the equations for power and work done.

Question 10

Many weaker candidates incorrectly believed that the smoke particles moved randomly because they are less dense than air, and therefore chose option **B**.

Question 12

Candidates found this question challenging. Most candidates recognised that the temperature would increase when the air inside the cylinder was heated, but many candidates believed that the pressure would also increase even though there was a moveable piston in the cylinder.

Question 14

Most stronger candidates chose the correct option. However, a significant number of weaker candidates confused condensation and evaporation and incorrectly chose option **C**.

Question 16

Most stronger candidates chose the correct option. However, weaker candidates struggled to apply their knowledge of wavelength and amplitude to the diagram, choosing mainly options **A** or **B**.

Question 17

The majority of candidates demonstrated poor knowledge about seismic waves with strong evidence of guesswork as answers were spread across all four options almost equally.

Question 19

The majority of candidates found this question very challenging. The main misconception was that if the angle of incidence was larger than the critical angle, there would still be a refracted ray, so option **B** was the most common option chosen.

Question 30

Candidates found this question on induced electromotive force challenging. Many stronger candidates answered it correctly, but a common misconception of both stronger and weaker candidates was that the speed of the magnet did not affect the magnitude of the induced e.m.f.

Question 34

Candidates struggled to recall the necessary facts about radioactive decay by the emission of an alpha particle. The majority of candidates demonstrated poor knowledge with strong evidence of guesswork as answers were spread across all four options almost equally.

Question 36

Although most stronger candidates knew that lead was the best material to use for lining the box, a significant number of candidates incorrectly thought that aluminium was the best material and therefore chose option **A**.

Question 39

Candidates demonstrated good knowledge about the radiation emitted by the Sun.

PHYSICS

Paper 0625/12
Multiple Choice (Core)

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

General comments

Candidates demonstrated very good understanding of pressure in liquids, change of state, electrical conductors and what the Universe is made up of. However, there were some misconceptions about thermal radiation and sources of ionising radiation. It was evident that candidates struggled to recall some equations.

Comments on specific questions

Question 1

This question required candidates to subtract the two times in the table in order to determine the shortest time for the second lap. Most stronger candidates did this correctly. However, weaker candidates struggled to interpret the table and were more likely to choose option **B** as it was the smallest time.

Question 3

Most candidates correctly recalled that the unit of gravitational field strength is N / kg and therefore chose either option **B** or option **D**. However, some of these candidates believed that velocity is a change in speed instead of the speed in a given direction and therefore incorrectly chose option **B**.

Question 4

Although most candidates recalled that the weight of an object is linked to gravitational force, many incorrectly believed that weight is the gravitational force per unit mass rather than the gravitational force on an object, so chose option **A**.

Question 5

The majority of candidates found this question challenging and there was evidence that they did not read all of the information carefully enough. Most candidates misinterpreted the question, confusing the extension with the length of the spring and therefore read the value for the load on the graph when the extension was 6 cm instead of when the extension was 4 cm.

Question 7

Many candidates struggled to recall the quantities needed to calculate the work done on the box. Most candidates incorrectly believed that the width of the stairs was required in the calculation.

Question 15

Although many stronger candidates answered this correctly, a significant number of other candidates incorrectly thought that thermal radiation cannot travel through a vacuum and therefore chose option **B**.

Question 18

Most stronger candidates gave the correct response about the reflection of a ray of light. Many weaker candidates thought that line Z was the principal focus.

Question 22

Only stronger candidates answered this correctly. The most common incorrect answer was option **C**, indicating that candidates had forgotten to halve the time given. For numerical questions, candidates would benefit from writing down the relevant equation and their calculations to work out the answer before looking at the different options.

Question 24

Candidates found this question on the direction of the magnetic field lines quite challenging. Stronger candidates were more likely to choose the correct option, but it was notable that the responses of other candidates were evenly distributed across the four possible responses, indicating that some had guessed the answer.

Question 26

Only stronger candidates answered this correctly. Other candidates could not recall the correct equation to calculate power dissipated by the resistor, with responses evenly distributed across the four possible responses indicating that many had guessed the answer.

Question 34

Candidates demonstrated poor knowledge about ionising radiation with many candidates incorrectly believing that radio and TV transmissions contribute to a person's annual dose of ionising radiation.

Question 39

Most candidates demonstrated good knowledge about the objects that make up the Universe.

PHYSICS

Paper 0625/13
Multiple Choice (Core)

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

General comments

Candidates demonstrated very good understanding of determining the density of liquids, change of state, and the types of radiation emitted by the Sun. However, there were some misconceptions about the wavelengths of electromagnetic waves and converging lenses. Candidates also struggled to recognise the graph which showed a.c. voltage.

Comments on specific questions

Question 5

This question required candidates to read the volume of the liquid in the measuring cylinder and use this value to determine the density of the liquid. Most candidates were able to do this correctly.

Question 9

Candidates demonstrated an excellent understanding of the terms used to describe changes in state, with the vast majority of candidates choosing the correct response.

Question 12

Although most candidates answered correctly, many weaker candidates incorrectly thought that the water was absorbing heat from the surroundings, despite the tub being insulated.

Question 18

The majority of candidates across the ability levels found this question challenging and demonstrated poor knowledge about converging lenses. Most candidates thought that the beam of light converged to F_2 or to the right of F_2.

Question 19

Most stronger candidates chose the correct option. However, many weaker candidates incorrectly believed that the relationship $i = r$ was related to the refraction of light as it enters glass.

Question 21

This question about electromagnetic waves proved very challenging for all candidates, with responses evenly distributed across the four possible responses indicating that many had guessed the answer. Some candidates incorrectly thought that X-rays have the longest wavelength and radio waves or microwaves have the shortest wavelength.

Question 23

Few candidates answered this correctly. The most common incorrect answer was option **B**, indicating that candidates had forgotten to halve the time given. Weaker candidates often chose option **D**, indicating that they did not rearrange the equation correctly to calculate distance. For numerical questions, candidates would benefit from writing down the relevant equation and their calculations to work out the answer before looking at the different options.

Question 26

Candidates found this question on a.c. voltage challenging. Stronger candidates tended to confuse d.c. voltage with a.c. voltage and chose option **A**. Weaker candidates appeared to think that because the graph line was going up and down, it meant that the voltage was changing direction so chose option **C**.

Question 38

Candidates struggled to apply their knowledge of light-years in this question. The most common error appeared to be due to candidates not reading the question carefully enough. Many candidates chose option **C** because they did not take into account the time for the return journey and only calculated the time from the Sun to the star. There was strong evidence of guesswork as answers were spread across options **A**, **B** and **D** almost equally. Candidates would benefit from underlining key words and phrases in questions to help them focus.

Question 39

Most candidates demonstrated good knowledge about the radiation emitted by the Sun.

PHYSICS

Paper 0625/21
Multiple Choice (Extended)

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

General comments

Questions on mass and weight, forces in equilibrium and changes of state were answered well. However, there were some misconceptions about gas pressure.

It was evident that questions involving change in momentum, optical fibres and diodes were not well understood.

Comments on specific questions

Question 6

This question assessed candidates' knowledge of change in momentum. Few candidates answered it correctly. Candidates did not note that v_1 and v_2 were in opposite directions and therefore so were the momentums, so the majority of candidates chose option **D**.

Question 9

Candidates demonstrated excellent knowledge of changes of state, with nearly all stronger candidates and most weaker candidates answering this question correctly.

Question 10

Most stronger candidates answered this question correctly. Although most weaker candidates recognised that the force per unit area would double, some of these candidates chose option **A** as they incorrectly thought that the kinetic energy of the gas particles would double even though the temperature remained constant.

Question 11

Candidates found this question about gas pressure more challenging. Many stronger candidates recalled that as the volume increased, the pressure decreased but did not identify that it was an inversely proportional relationship, so chose option **A**. Many weaker candidates incorrectly believed that pressure and volume were directly proportional and therefore chose option **C**.

Question 14

Due to an issue with **Question 14**, this question has been discounted. Each candidate's total mark has been multiplied by a weighting factor so that the maximum mark for the question paper remains unchanged.

Question 17

Some candidates answered this question about reflection correctly, but it was challenging for weaker candidates with most of these candidates choosing incorrect options **B** or **C**. Many stronger candidates also thought that the maximum angle could only be 90° and so chose option **C**.

Question 20

Most candidates found this question very challenging and showed poor understanding of how the amount of light transmitted by the optical fibre depended on the relationship between the speed of light in the glass and the critical angle. Responses were evenly distributed across the four options.

Question 22

This question required candidates to determine the wavelength from the information provided, convert centimetres into metres, and then recall and rearrange the equation for wave speed to calculate frequency. Many stronger candidates were able to do this correctly. The most common error made by stronger candidates was misinterpreting the information so that they used the wrong value for the wavelength. The most common errors made by weaker candidates included using the wrong value for the wavelength and forgetting to convert the units into metres.

Question 27

Candidates demonstrated poor knowledge of the behaviour of a diode in a circuit and the correct graph was the least chosen answer overall. There was evidence that some stronger candidates recalled that a diode only lets current pass in one direction as most of these candidates chose option **C** or **D**. However, more stronger candidates chose option **C** as they did not take into account the initial polarities of terminal X and terminal Y.

Question 30

This question assessed candidates' knowledge of the force on a wire in a magnetic field. Stronger candidates answered the question correctly but other candidates' responses were evenly split between the other options, indicating some guesswork.

Question 36

In this question, candidates had to work out the corrected count rate for a radioactive source when given the number of counts per second and the background count rate. Most stronger candidates chose the correct answer. However, weaker candidates either worked out a count rate without any corrections for background radiation (option **B**) or subtracted the background count rate from the initial reading on the detector but forgot to add the background count rate back on to the count rate they calculated for the radioactive material after 68 hours (option **C**).

PHYSICS

Paper 0625/22
Multiple Choice (Extended)

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

General comments

Questions on mass and weight, speed–time graphs and changes of state were answered well. There were some misconceptions about diffraction and which energy resources have the Sun as their main source of energy.

It was evident that questions about gas pressure, a.c. generators and uses of radioactive sources were not well understood.

Comments on specific questions

Question 2

Candidates demonstrated excellent knowledge of speed–time graphs and nearly all stronger candidates chose the correct response **C**, but some weaker candidates thought that the area under the graph represented acceleration.

Question 3

This question was answered correctly by all stronger candidates. Some weaker candidates could not recall the correct equation to calculate weight and instead divided the mass by the gravitational field strength.

Question 7

This question assessed candidates' knowledge of energy resources. Many stronger candidates chose the correct option but overall the responses from candidates were distributed across the four options, with weaker candidates incorrectly believing that the Sun is the main source of energy for a geothermal energy resource.

Question 11

Candidates found this question about gas pressure challenging. Many stronger candidates recalled that as the volume increased, the pressure decreased but did not identify that it was an inversely proportional relationship so chose option **C**. Many weaker candidates incorrectly believed that pressure and volume are directly proportional and therefore chose option **B**.

Question 15

Candidates had to use their knowledge of thermal energy transfer in this question. The majority of candidates knew that plastic is a poor thermal conductor. Many stronger candidates answered this question correctly but many weaker candidates were not aware that air is also a poor thermal conductor and therefore chose incorrect option **D**.

Question 18

Many stronger candidates answered this question about diffraction correctly. Most candidates knew that the speed had to be kept constant, but most weaker candidates incorrectly believed that the frequency had to be increased instead of decreased.

Question 19

Candidates performed very well in this question about reflection in a plane mirror with the majority of candidates choosing the correct answer.

Question 26

This question about a.c. supply and d.c. supply was answered correctly by all stronger candidates. However, although weaker candidates correctly identified that the *y*-axis of the graph represented voltage, they mixed up the graphs for a.c. supply and d.c. supply and so chose option **C**.

Question 31

Candidates found this question about a simple a.c. generator extremely challenging with only a small proportion of stronger candidates choosing correct option **A**. Instead of recalling that the maximum induced e.m.f. occurs when the magnetic field at position Q is changing most rapidly, most stronger candidates incorrectly thought that the induced e.m.f. is zero when the magnetic field at position Q is zero (option **B**). The majority of weaker candidates incorrectly chose option **C**.

Question 36

In this question, candidates demonstrated poor knowledge of the use of radioactive sources to measure and control the thickness of paper. Candidates' responses were split between all four options, indicating some guesswork. A few stronger candidates chose the correct option. As many candidates appeared to know that alpha particles can be stopped by paper, these candidates concluded that alpha emission was therefore the most suitable type of emission to use and made the common error of choosing option **A** or **B**.

Question 38

Most stronger candidates could apply the equation to calculate the average orbital period of the Earth correctly. Weaker candidates often incorrectly chose option **C** as they did not convert 365 days into seconds.

PHYSICS

Paper 0625/23
Multiple Choice (Extended)

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

General comments

Questions on speed–time graphs, thermal conduction and the structure of an atom were answered well. There were some misconceptions about Brownian motion and change of state. It was evident that questions involving refractive index, conservation of momentum and electrical circuits (containing LEDs, relays, thermistors and LDRs) were not well understood.

Comments on specific questions

Question 6

This question was answered correctly by nearly all stronger candidates. Many weaker candidates also answered this correctly, but the most common error was that the volume of an object cannot be changed by applying forces.

Question 7

This question assessed candidate’s abilities to apply the principle of the conservation of momentum. Most stronger candidates applied the principle and rearranged the equation correctly. However, weaker candidates found this question very challenging, with very few correct answers, and most choosing option **B** or **C**.

Question 9

The strongest candidates were able to identify the correct option. Other candidates incorrectly believed that the particles of metal move much further apart when the solid metal melts to become a liquid.

Question 10

Candidates demonstrated a good understanding of Brownian motion of particles with all stronger candidates and many weaker candidates choosing the correct answer. However, a significant number of weaker candidates believed that all the particles travel in the same direction and along a curved path and so chose option **A**.

Question 14

This question about what happens to energy and temperature as ice at 0 °C melts to become water was answered correctly by most stronger candidates, who knew that energy is absorbed while the temperature remains constant. Most weaker candidates incorrectly thought that the temperature rises during this change in state and therefore chose option **B** or **D**.

Question 16

Most candidates demonstrated a very good understanding of thermal conduction in the different states of matter.

Question 20

Many candidates struggled with this question where they had to link the definition and the equation for refractive index. Only stronger candidates answered this correctly with the most common errors being option **C** or **D**.

Question 21

Most stronger candidates demonstrated a good understanding of a converging lens used as a magnifying glass, but weaker candidates' responses were distributed across the four options, indicating some guesswork.

Question 25

Most stronger candidates answered this question correctly but weaker candidates incorrectly thought that the direction of the magnetic field is towards both the N pole and the S pole and therefore chose option **D**.

Question 30

This question assessed candidates' knowledge of the relationship between the resistance of a wire, its length and its cross-sectional area. Most stronger candidates applied the correct relationships and chose option **D**. Weaker candidates' responses were distributed fairly equally across the four options, indicating misunderstandings of the relationships or some guesswork.

Question 31

The majority of candidates struggled to apply their knowledge of how LEDs, relays, thermistors and LDRs behave in electrical circuits. Candidates' responses were spread across the four options indicating that candidates were guessing the answer or had misunderstandings of how the components behaved.

Question 40

Candidates had to recall the distance travelled by light in one year and most stronger candidates answered this correctly. However, although many weaker candidates chose the correct number, most thought the unit was km instead of m and therefore chose option **D**.

PHYSICS

Paper 0625/31
Theory (Core)

Key messages

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

Some of the candidates' handwriting made it difficult to distinguish what they were writing. There were issues differentiating between 1 and 7, 4 and 7, 6 and 0, 9 and 0, 9 and 4, 7 and 9. Centres should encourage candidates to ensure that working and answers to numerical questions are as clear as possible. Candidates who wish to change their final numerical answer should cross out the incorrect version and write the correct value clearly.

General comments

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

A high proportion of candidates displayed a good understanding of the English language, and almost all candidates had a sufficient understanding to be able to attempt the questions. However, the use of pronouns, such as 'it' and 'they' without making it clear what these pronouns were referring to, especially in comparison questions, often made responses unclear.

Almost all candidates attempted all of the questions and there appeared to be sufficient time for candidates to complete the paper.

Comments on specific questions

Question 1

(a) (i) This question was usually well answered. The most common error was to consider S to be at rest. Candidates should be encouraged to study the labelling on the axes of graphs. Many candidates treated this as a distance–time graph.

(ii) Most candidates realised that the answer required them to read a value from the graph and answered correctly. A very small number thought the graph was a distance–time graph and incorrectly tried to calculate the speed.

(iii) Many candidates realised that the calculation involved finding the area under the graph which led to the correct answer of 40 m. Some candidates tried to find the answer using distance = speed × time with varying success. Some correctly used average speed and calculated the correct answer. Others calculated the answer to be 80 m by omitting the half for the area of a triangle. Most candidates showed their working and so were able to gain partial credit even with an incorrect final answer.

(b) Only a few candidates realised that velocity required speed and distance and showed this in one of several ways. Most candidates considered speed and velocity to be synonymous, with others thinking that velocity was used in very specific cases such as the speed of waves.

Question 2

(a) Many candidates found this question challenging. However, most calculated the average thickness correctly. Common errors included dividing 5.4 by 100 or 100 by 5.4.

(b) This question was well answered with most candidates describing a displacement method to gain full credit. Some candidates described putting the stack of masses in first and then added water. These candidates had some understanding of the procedure but described a method that could not work. A common error was not using the word ‘volume’ for the measurements in the measuring cylinder. Reading, height and measurement were common incorrect answers. Centres should encourage candidates to specify any quantities being measured clearly.

Question 3

(a) (i) The concept of a resultant force was understood well by almost all candidates, who gave 120 N to the right to earn full credit. Answers that gave the direction as a compass point, e.g. East, did not gain credit unless at least one compass point, e.g. North, was indicated on the diagram.

(ii) Many candidates answered this correctly. Common errors were to give vague responses that did not include a direction, e.g. because of the wind, water or waves.

(iii) Many candidates believed that no force means no movement and this was the most common answer. Other common errors included imprecise answers such as constant motion. Only stronger candidates gave the correct answer of constant speed. This is an area where centres are advised to give some practice examples.

(b) This question was answered very well by many candidates who gave clearly set out methods for their responses. A few candidates divided the values for force and distance. There were many unit errors, usually N / cm or N / m.

Question 4

(a) Most candidates showed a wide knowledge base for this question, but they were not always able to express themselves with sufficient precision. For example, many candidates stated that pollution was a problem rather than being specific and answering, ‘air pollution’. General or vague answers about damaging the environment or endangering wildlife were insufficient for credit.

(b) (i) Many candidates gave several good points about how a hydroelectric power station generates electricity and gave good coherent descriptions. However, it appears that many candidates had a detailed knowledge of one renewable means of generating electricity and one non-renewable method. These candidates tended to give a standard answer regardless of which type of power station was asked for. Therefore, in responses to this question, there were references to wind generation, wave generation, tidal, geothermal and even solar cells being the energy source. There were some candidates who described the water being heated to form steam that was used to drive the generator. Centres should encourage candidates to carry out thorough research into how the different renewable energy sources can be harnessed to generate electricity.

(ii) Many candidates gave valid disadvantages of building a hydroelectric scheme. However, many answers were lacking in detail. For example, candidates said that it “depends on weather” rather than them needing rain.

(c) Very few candidates gave correct answers here even though the topic is of great importance. Few gave a suitable method of storing the unused energy. Common incorrect answers included “use a generator/transformer” or “in a power station” or “underground”.

Question 5

(a) Many candidates were able to give good answers to this question and there was a good understanding of the topic by most candidates. The only common error was for candidates to give several answers that were essentially the same property. Those candidates who used the structure of the question to formulate their answers by giving one answer about arrangement, one about separation and one about the motion, usually gave three different, correct answers.

(b) (i) This question was answered well with most candidates knowing that work done is equal to force × distance moved, and giving a correct answer of 5.4 J. Those who did not answer correctly usually used an incorrect rearrangement of the equation i.e. force ÷ distance or 30/0.18.

(ii) Most candidates knew that the pressure increased but several were unable to give a reasoned explanation. The key idea that there were more frequent collisions (with the wall of the container) was rarely seen. Most simply said "more collisions". Others thought that kinetic energy or speed increased even though a constant temperature was specified in question.

Question 6

(a) Most candidates knew that the rod where the wax melted quickest was the best conductor of heat. However, some did not clearly state this and instead stated that they would see which melted first. Some candidates managed to answer this without mentioning melting wax or conductors. A few described attaching balls or pins to the wax or using a thermometer, which did not answer the question.

(b) (i) Many candidates evaluated a correct substitution. Others used an incorrect rearrangement of the equation $v = f \times \lambda$ while some used the correct formula but incorrectly handled the powers of ten. Many of these candidates gave their answer as 150 Hz.

(ii) Almost all candidates gave a region of the electromagnetic spectrum but many of these did not give a region that has wavelengths longer than infrared. Most candidates were able to give a suitable use for the region that they had chosen.

Question 7

(a) (i) This question was answered well by most candidates. The most common error was to identify a ray rather than an angle and occasionally to indicate the angle of incidence.

(ii) Most candidates gave the correct answer of 40°. The most common error was 50° but 80°, 90°, 140° and various values close to but not equal to 40 were regularly seen.

(b) (i) (ii) This question was well answered by most candidates with correct rays often drawn, and a sensible answer given for showing the location of the image. The most common error was to draw the ray through the centre of the lens deviated along the principal axis.

(c) (i) Only a minority of candidates could recall that the production of a spectrum for visible light by a prism was known as dispersion. The most common errors were refraction and diffraction.

(ii) The colours of the visible light spectrum were well known by most candidates. Only a few candidates had the order reversed.

Question 8

(a) (i) Most candidates knew that iron was a suitable material for the core of the electromagnet. The most common error was steel or iron and steel.

(ii) This question was answered well with most candidates evaluating the correct number of cells from 12 ÷ 1.5 = 8 cells. The most common error was to multiply the two values i.e. 12 × 1.5 = 18 cells.

(b) (i) Most candidates knew that a compass was needed to determine the direction of a magnetic field. Some common errors were iron filings or galvanometer or magnet.

(ii) Many candidates found this question challenging. Most gave an incorrect answer of south pole. Only stronger candidates correctly identified X as a north pole.

(c) Many candidates correctly evaluated their substitution into $V = I \times R$ to give the correct answer of 9.6 V. The most common errors involved using incorrect rearrangements of the equation such as $V = I \div R$ or $V = R \div I$. Candidates would benefit from practicing the rearrangement of common equations in the syllabus.

Question 9

(a) (i) This question was challenging for many candidates. Few candidates could recall the names of the three wires in a mains cable. Most of those who gave the name of one or two of the wires, could not name the third. Common errors included positive, negative or lists of metals.

(ii) Many candidates realised that there would be overheating (or as they often said, burning). The most common errors were electrocution/exploding/blow fuse.

(b) (i) The majority of candidates correctly evaluated the transformer equation to give the correct answer of 16 V. These candidates usually set out the equation and then substituted values before rearranging and evaluating. Candidates who tried some form of cross-multiplication often did not reach a correct answer.

(ii) Only stronger candidates correctly evaluated the power as 320 W. A common error was to divide voltage by current. Centres should encourage candidates to practise writing out the equation for power as $P = I \times V$. There seemed to be some confusion with the equation $V = I \times R$.

Question 10

(a) (i) (ii) Both parts of this question were answered well by most candidates, with many giving correct answers of 52 for **(i)** and 38 for **(ii)**. The most common errors were 90 and 128.

(b) Many candidates found this question challenging with only stronger candidates correctly identifying a beta particle as an electron. The most common error was giving properties of β particles rather than their nature.

(c) Most candidates made a good attempt at this calculation with many scoring full credit for an answer of 87 years. The most common error was to calculate that there were three half-lives but then to divide the half-life of strontium-90 by three i.e. 29 ÷ 3.

Question 11

(a) Most candidates managed to give at least one other category of bodies in the Solar System apart from the Sun and planets. However, the most common error was planets (including named planets) and even stars or galaxies.

(b) Almost all candidates recalled that the galaxy containing our Solar system was the Milky Way.

(c) Only stronger candidates gave detailed and accurate descriptions about how the light from distant galaxies gives evidence to support the Big Bang Theory. Many candidates scored partial credit for describing the redshift of light from distant galaxies.

PHYSICS

Paper 0625/32
Theory (Core)

Key messages

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

Some of the candidates' handwriting made it difficult to distinguish what they were writing. There were issues differentiating between 1 and 7, 4 and 7, 6 and 0, 9 and 0, 9 and 4, 7 and 9. Centres should encourage candidates to ensure that working and answers to numerical questions are as clear as possible. Candidates who wish to change their final numerical answer should cross out the incorrect version and write the correct value clearly.

General comments

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

A high proportion of candidates displayed a good understanding of the English language, and almost all candidates had a sufficient understanding to be able to attempt the questions. However, the use of pronouns, such as 'it' and 'they' without making it clear what these pronouns were referring to, especially in comparison questions, often made responses unclear.

Almost all candidates attempted all of the questions and there appeared to be sufficient time for candidates to complete the paper.

Comments on specific questions

Question 1

(a) The majority of candidates answered this correctly. The most common errors were stating increasing acceleration or confusing the speed–time graph with a distance–time graph and stating "steady speed".

(b) Many candidates gained credit by realising that the graph between 4.0 and 8.0 s was horizontal i.e. the gradient of the graph was zero, and gave a correct answer of zero. The most common error was to give the speed of the car which was 20 m / s.

(c) The majority of candidates realised that the calculation involved finding the area under the graph, which led to a correct answer of 60 m. The most common error was forgetting to multiply by a half, leading to an answer of 120 m.

Question 2

(a) This question was answered well, with most candidates describing a displacement method to gain full credit. Other candidates put the piece of metal into the measuring cylinder before the water. A number of candidates did not use the word 'volume' for the measurements in the measuring cylinder. Reading, height and measurement were common incorrect answers. Centres should encourage candidates to specify clearly any quantities being measured.

(b) Most candidates correctly calculated the density as 6.4 g / cm^3. The most common errors involved an incorrect rearrangement of the density equation. A number of candidates gave an incorrect unit for density.

Question 3

(a) Candidates found this question challenging with many giving inadequate descriptions, for example "the cone has more surface area". Very few candidates recognised that the centre of mass of the cone would be lower.

(b) Most candidates correctly calculated the weight of the cylinder as 2.5 N. Those who did not usually divided the mass by *g*.

(c) (i) Most candidates correctly calculated the moment as 66 N cm. The most common error was using an incorrect rearrangement of the equation. Candidates should be encouraged to write down the equation before attempting to rearrange it.

(ii) Only stronger candidates realised that the moment of the weight of the cone was the same as the answer to **(i)**.

Question 4

(a) (i) Only stronger candidates recognised that the two useful energy transfers were light and sound. Centres should encourage candidates to write down energy transfers to and from common domestic appliances.

(ii) The vast majority of candidates correctly calculated the wasted energy as 70 J.

(b) (i) Many candidates were unable to give detailed enough descriptions of how a hydroelectric power station generates electrical power. Many recognised that the flow of water from the reservoir to the power station was needed to generate power, but few could then describe the rotating of a turbine which in turn rotated a generator. The most common errors involved the use of completely different energy sources, e.g. using the wind to turn the turbines and even boiling the water to make steam to turn the turbines. Centres should encourage candidates to carry out thorough research into how the different renewable energy sources can be harnessed to generate electricity.

(ii) Many candidates did not express themselves with sufficient precision. For example, many candidates stated that no pollution was an advantage, rather than being specific and stating no air pollution or greenhouse gases.

Question 5

(a) Most candidates had a good understanding of the basic ideas of the simple kinetic theory model and were able to give descriptions scoring either full or partial credit.

(b) (i) Many candidates scored full credit, but the majority described a change in either the motion or the separation of the particles, but not both. Weaker candidates did not relate their understanding to particles in a solid and referred to the particles moving about with a slower speed.

(ii) Many candidates did not recognise that at absolute zero, the particles would stop vibrating or have less kinetic energy.

(c) Most candidates correctly calculated the pressure as 0.62 N / cm^2. There were a number of candidates who gave a rounding error in their answer, i.e. 0.61. Another common error was to use an incorrect rearrangement of the equation $P = F \div A$. The most common of these was $F \times A$.

Question 6

(a) Many candidates scored full credit for an answer of 20 cm / s. The most common errors were using an incorrect rearrangement of $v = f \times \lambda$ and attempting to use speed = distance ÷ time, with frequency substituted for the time.

(b) Most candidates correctly identified refraction, but few were able to explain this in terms of changes of speed or wavelength due to a change in depth.

(c) (i) Most candidates correctly identified a region of the electromagnetic spectrum with wavelengths longer than visible light.

(ii) Some candidates gave one use of ultraviolet radiation but many did not gain credit here. Common errors included vague responses such as "used in scans" or incorrect uses such as "used in X-rays or mobile phones".

(iii) Some candidates did not know that in a vacuum, radio waves and gamma rays travel at the same speed.

Question 7

(a) The majority of candidates correctly calculated the resistance of the lamp as 12 Ω. The most common error was using an incorrectly rearranged form of the equation $V = I \times R$. The most common of these was $R = V \times I = 4.8 \times 0.4 = 1.92$.

(b) Some candidates recognised that the brightness of the lamp would increase, but many could not explain how the resistance of the circuit had been decreased by closing switch S.

Question 8

(a) Many candidates did not recall the equation for energy transferred, $E = I \times t \times V$. The most common error was the use of the equation for electrical power. Those who did recall the correct equation often did not convert the time to seconds. Centres should encourage candidates to practise writing out the standard forms of all the equations in the core subject content and then to practise rearranging the equations.

(b) (i) Many candidates recalled that the material used for the core of the transformer was iron. Common errors included copper, aluminium and steel.

(ii) This question was answered well by most candidates, with many scoring full credit for evaluating the number of turns on the output coil as 320.

Question 9

(a) The majority of candidates correctly identified the fault as damaged insulation and the hazard as electrocution. Some answers lacked detail, with answers such as "the wire is damaged".

(b) (i) Many candidates identified wire X as the earth wire. Common errors included copper wire, negative wire and positive wire.

(ii) The majority of candidates identified the live wire, but only a few were able to give a correct explanation for positioning the fuse in the live wire.

Question 10

(a) (i) Most candidates correctly stated that both isotopes contained 92 protons. The most common error was confusing the proton and nucleon numbers.

(ii) The majority of candidates recognised that U-238 had three more neutrons than U-235. As in **(i)**, the most common error was confusion between proton and nucleon numbers.

(b) Many candidates were able to correctly evaluate the time taken for the isotope to decay from 16 mg to 4 mg as 48 minutes. Some correctly demonstrated that it took 2 half-lives for the isotope of uranium to decay but were then unable to use this information to evaluate a time in minutes.

Question 11

(a) (i) Many candidates gained credit for stating that Earth has a greater mass than Venus. The most common error was to try to link gravitational field strength of a planet to its distance from the Sun.

(ii) This calculation was usually done well, with the vast majority of candidates giving an answer of 243 Earth days. A common error among weaker candidates was then to divide the correct answer by 60.

(iii) The majority of candidates gained partial credit, but only stronger candidates answered fully correctly with an answer of 360 seconds. The most common errors involved a power of 10 error in the calculation.

(b) The majority of candidates correctly stated that one light-year is the distance travelled in space by light in one year. The most common error was to refer to a light-year as a unit of time.

PHYSICS

Paper 0625/33
Theory (Core)

Key messages

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

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

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

General comments

Some areas of the syllabus were better known than others. In particular, energy resources and energy stores, certain aspects of the general properties of waves, the reflection and refraction of light, the application of the electrical power equation, high-voltage transmission of electricity, radioactive emission and the Universe were not well understood. Equations were generally well known by all but the weakest candidates. Many candidates understood how to apply equations to standard situations well.

For many candidates, the non-numerical questions were more challenging than the numerical questions. A noticeable number of candidates struggled to express themselves adequately when answering the extended writing questions. One example of this was the use of the pronouns 'it' and 'they' without making it clear what 'it' and 'they' referred to. Similarly, candidates frequently stated a property had changed but failed to state how it had changed i.e. whether it had increased/decreased.

Comments on specific questions

Question 1

(a) (i) The majority of candidates answered this correctly.

(ii) Many candidates answered this correctly. The most common incorrect answer was force B.

(iii) Many candidates gave the correct answer, but a significant number did not recognise the effect that a resultant force would have on the motion of an object.

(b) (i) Many candidates answered this question well with many showing both the correct equation and full working. Weaker candidates often used an incorrect equation i.e. speed = distance × time or gave no response.

(ii) A significant number of candidates gained full credit here and showed full working with the correct unit. However, some candidates used an incorrect equation. The most common errors were using work done = distance ÷ force, work done = force ÷ distance or work done = distance ÷ time.

Question 2

(a) Many candidates gained full credit with most showing both the correct equation and full working. However, some candidates recalled the moment equation incorrectly.

(b) Many candidates gained partial credit for “making the base heavier”, but this was rarely linked to lowering the centre of gravity as the reason for more stability. Other candidates gained credit for “increasing the area of the base” without linking this to the idea that the sign would need to tip through a greater angle before falling over.

Question 3

Candidates generally lacked the knowledge for this question.

(a) (i) Energy can be stored as kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic or internal (thermal). The energy store for hydroelectric power is gravitational potential. Incorrect answers were common, e.g. energy sources such as tidal, geothermal, etc. or simply hydroelectric.

(ii) The majority of candidates did not realise that only a turbine and a generator are required in a hydroelectric power station.

(b) (i) Candidates needed to recognise that a step-down transformer was required. There were a considerable number of candidates who did not give any answer.

(ii) Answers were generally vague and there was a noticeable number of candidates who gave no response. A number of candidates realised that the energy losses would be reduced and/or there would be a lower current. The ideas that a lower current would allow for example, thinner cables to be used and therefore, increased spacing between pylons were seldom seen.

(c) Many answers needed to be developed further. For example, simply stating “pollution” or “environmentally friendly” was too vague. Stronger responses were seen for the advantages, based on using hydroelectric as not “contributing to global warming” or “producing acid rain”. For the disadvantages, answers such as “dependent on the weather” were too vague, whereas “dependent on rainfall” was credited.

Question 4

(a) (i) (ii) Most candidates had a good understanding of the basic ideas of the simple kinetic theory model and answered well here.

(iii) Some candidates only described one aspect of the motion, usually that the motion was random. Two aspects were required for full credit.

(b) (i) The vast majority of candidates gave the correct answer.

(ii) There were a wide variety of answers but only the strongest candidates gained full credit. Most candidates correctly stated that the liquid molecules became gas or vapour molecules. A number of candidates focused their answers on the cooling effect of evaporation, but this was not required here.

Question 5

(a) Candidates needed a fuller understanding of how density changes explain the formation of convection currents in liquids. A number of candidates gained partial credit for explaining that convection currents were involved and/or that the hot water would rise.

(b) (i) Many correct answers were seen. However, other candidates gave convection as their answer. More careful reading of the question would have eliminated this incorrect answer as the question referred to the walls of a metal container. There were also a significant number of candidates who gave no response.

(ii) Many candidates realised that covering or lagging the container with an insulator (or a named insulator, e.g. cotton wool) was a good way of keeping the water hot. Other answers tended to be too vague or candidates gave an answer that did not relate to the situation, e.g. “put a lid on the container”.

Question 6

(a) Confusion between transverse and longitudinal waves was evident here. There were also a significant number of candidates who gave no response.

(b) (i) Many candidates correctly identified diffraction. There was an even split between the incorrect answers of refraction and dispersion.

(ii) Few candidates recognised that the wavelength was the distance between two successive wave crests. A high number of candidates gave no response.

(c) Many candidates scored full credit for an answer of 8.2 Hz with most showing both the correct equation and full working. The most common errors were using an incorrect rearrangement of $v = f \times \lambda$, or attempting to use speed = distance ÷ time, with frequency substituted for the time.

Question 7

(a) (i) Candidates either lacked the knowledge of what a normal was or lacked the experience of drawing a normal at a point on a sloping boundary. Many candidates gave no response.

(ii) Most candidates had the correct general idea and stronger candidates gained full credit. Other candidates confused the prism with the action of a parallel sided block and drew the emergent ray parallel to the incident ray. Candidates need to be aware that a ray of red light will not disperse.

(b) Very few candidates knew that the ray of blue light would refract more than the ray of red light. Some candidates did not give a response.

(c) Only stronger candidates were able to recall the conditions for a ray to be totally internally reflected. Some candidates did not give a response.

Question 8

(a) Many candidates answered this question well. A common error was placing the voltmeter in series with the ammeter. Some candidates did not give a response.

(b) The majority of candidates correctly calculated the resistance of the lamp to be 29 Ω. A common error was using an incorrectly rearranged form of the equation $V = I \times R$ with the most common of these being $R = V \times I$.

(c) Many candidates did not recall the equation for power transferred as $P = I \times V$. Incorrect attempts to find the power using power = energy ÷ time and $V = I \times R$ were seen. Some candidates did not give the correct unit. Some candidates did not give a response.

Question 9

(a) Generally, candidates did not recognise the magnetic properties required for the parts of the devices shown. Most achieved partial credit for an awareness that copper was the suitable metal for the coils of a transformer.

(b) This question was answered well by many candidates, with some gaining full credit for evaluating the output voltage to be 95 V. Weaker candidates gained partial credit for recalling the transformer equation correctly but were not able to rearrange the equation correctly. Some candidates did not give a response.

Question 10

(a) (i) The majority of candidates correctly stated that the number of protons was 91. The most common error was confusing the proton and nucleon numbers.

(ii) Only stronger candidates identified the number of nucleons. As in **(i)**, the most common error was confusion between proton and nucleon numbers.

(b) Many candidates realised that these different forms were isotopes. Some candidates did not give a response.

(c) (i) Only a few candidates knew that beta particles are electrons. A common answer was negative charge. Several candidates did not give a response.

(ii) This question was answered well by many candidates, usually with clear workings shown on the graph. Weaker candidates tended to halve the initial count rate giving the incorrect answer of 450 s.

(iii) Many candidates knew that the small half-life enabled sufficient time in a lesson to collect enough data for a decay curve. Other candidates focused their answer on safety issues or gave no response.

Question 11

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

(b) (i) (ii) Many candidates did not correctly distinguish between the Universe and galaxies. Some candidates did not give a response.

(c) (i) The majority of candidates correctly stated that one light-year is the distance travelled in space by light in one year. The most common error was to refer to a light-year as a unit of time.

(ii) Many candidates realised that these planets are too far away or the distances involved are vast. Common incorrect answers were that radio waves would not travel that far or that the spacecrafts could not carry sufficient fuel to get that far.

(d) Many candidates answered this question well and showed both the correct equation and full working. Weaker candidates often made a power of ten error in the calculation or used an incorrect equation i.e. speed = distance × time.

PHYSICS

Paper 0625/41
Theory (Extended)

Key messages

Candidates should be reminded to:

- read questions carefully
- answer exactly the question that is being asked (noting the context of the question)
- write clear definitions of key concepts
- write down the equation in symbols or words first
- use symbols given in the syllabus (or clearly define their own symbols)
- round numerical values to the number of significant figures to match given data
- always include the unit with a numerical final answer
- write legibly, taking special care to make number values unambiguous.

General comments

Candidates were well prepared for this examination, demonstrating a good understanding across the range of topics within the physics syllabus. The questions on space physics were answered confidently this year, with candidates showing a good understanding of the life cycle of stars.

In some questions, candidates recalled theory without applying it to the specific context in the question. **Question 2(b)** was about the energy transfer as a compressed spring expands. **Question 3(b)(iv)** required an explicit statement about what happens to internal energy. **Question 9(c)(i)** and **(ii)** broke the life cycle of a star into distinct parts and required the answer to each part separately.

Candidates should use the question and any diagram to understand what is happening in an experiment that may be similar to, but not the same as, a laboratory experiment they have done before. In **Question 2** the initial momentum was zero, so the momentum of the two trolleys needed to add up to zero. **Question 3** illustrated convection driven by cooling, rather than by heating.

As well as understanding and using key concepts, candidates need to be able to define concepts with clarity and precision. **Question 1(a)**, **Question 4(a)(i)**, **Question 5(a)**, **Question 6(a)(i)** and **Question 7(a)** all required a clear definition of a key syllabus concept.

Many candidates showed their working in numerical questions which allowed them to gain partial credit for correct physics when the final answer was incorrect.

When quoting a formula in symbols, candidates should use the variables given in the syllabus for quantities. Where they use an alternative symbol, it will only be accepted if it is clearly defined. Candidates should remember that T and θ are acceptable symbols for temperature and t is the symbol for time. Also, E is the symbol for energy and Q is the symbol for charge.

Candidates should always include the unit with a final answer. Answers to **Question 5(b)(ii)** and **Question 9(b)** were often given without a unit. Candidates should check that the final answer is written to an appropriate number of significant figures with correct rounding. The number of significant figures in the final answer should match the number of significant figures of the data provided in the question. **Question 2(a)(ii)** was often incorrectly rounded to 0.077 J. It was also often given to only one significant figure.

Comments on specific questions

Question 1

(a) Most candidates gave a clear, concise definition of acceleration. This was sometimes expressed as rate of change of velocity and at other times expressed as change in velocity per unit time. Giving the definition in the form $a = \Delta v \div \Delta t$, either in symbols or words also gained credit. Candidates need to know that the definition of acceleration may contain the word 'rate' or the phrase 'per unit time' but rate of change of velocity per unit time is not a correct definition.

(b) The vast majority of candidates correctly recalled and used the equation $F = ma$. To gain full credit, candidates needed to remember to include the unit in their answer and to give the numerical value to an appropriate number of significant figures. In this question, the data was given to two significant figures and so the answer should also have been given to two significant figures.

(c) (i) Stronger answers were well structured, described how acceleration changed and then explained this in terms of the forces acting on the ball. Stronger candidates stated that resistive force increases, and most candidates stated that the ball reached terminal velocity. Common misconceptions were the acceleration of the ball increasing, the ball slowing down and equating acceleration to resistive forces at terminal velocity.

(ii) This question required candidates to draw a tangent to the curve at $t = 0.010$ s. The strongest candidates calculated the gradient of a carefully drawn tangent, using coordinates spread apart on the tangent. Candidates should be reminded to use a sharp pencil to draw a thin tangent that intersects the curve exactly at $t = 0.010$ s. Weaker candidates either drew a tangent in the wrong place, e.g. at $t = 0$ or did not draw a tangent. Candidates need to know that a calculation of $v \div t$ at $t = 0.010$ s is not a valid method for finding the acceleration at that point.

Question 2

(a) (i) Many candidates correctly calculated the speed of trolley P, gave their answer to two significant figures and included the correct unit. Candidates who did not have a correct final answer gained partial credit for writing a conservation of momentum equation in words, symbols or by using numerical values from the question. Candidates needed to realise that in this question, the initial momentum and the final momentum were both zero, because the trolleys started at rest and then moved in opposite directions. A common misunderstanding among weaker candidates was to assume that the trolleys were sticking together after a collision. Other candidates assigned incorrect mass values to either or both of the trolleys and so they calculated an incorrect value of speed of trolley P.

(ii) Almost all candidates correctly recalled the equation $E_k = ½mv^2$. Candidates needed to be careful to substitute the numerical value of velocity squared into this equation. The answer needed to be rounded correctly, quoted to two significant figures and given the correct unit.

(b) Stronger candidates clearly identified that the transfer was from elastic/strain energy to kinetic energy. Candidates needed to realise that since the motion was horizontal, there was no transfer to or from the gravitational potential store. Some candidates identified the two energy stores but wrote the transfer from kinetic to strain energy.

Question 3

(a) Most candidates identified a difference in motion saying either that particles in ice vibrate in fixed positions or that particles in water slide over each other. Both answers implied a clear difference in the motion of the particles. Many candidates wrote both statements to give a very clear answer. Ambiguous answers such as that particles move faster in liquids did not identify a difference in particle motion. Weaker answers referred to inter-molecular spacing, energy or stated that particles are stationary in a solid.

(b) (i) Only the strongest candidates correctly stated that the thermal process transferring energy from liquid water to solid ice was conduction. Convection was the most common incorrect thermal process given. A common error was to give an answer about a change in state in the material, such as freezing or melting, rather than a thermal energy transfer process.

(ii) Most candidates correctly recalled and used the formula $c = E \div m\Delta\theta$. Candidates needed to remember that the final numerical answer should be given to the same number of significant figures as the data in the question, and the correct unit included. Many candidates wrote the equation in words or symbols first which was good practice. They should use recognised symbols for each term, such as θ or T for temperature. Candidates should be reminded that t is the symbol for time, not temperature and Q is the symbol for charge and not energy.

(iii) Stronger answers here identified how the density of water changes with temperature and then described a convection current in terms of cooler water falling and warmer water rising. The strongest answers avoided any mention of particles, recognising that convection in water is a bulk process of the fluid. A common misconception was to state that the density of water particles changed with temperature. Weaker answers described cooling due to evaporation or described energy transfer from water to ice without any reference to the water getting colder.

(iv) Many candidates recognised that the kinetic energy of the particles decreased as the water temperature decreased. For full credit, this needed to be combined with a clear statement that the internal energy of the water decreased. Weaker responses were vague, referring to an unqualified energy decreasing. Other weaker answers gave irrelevant information about particles slowing down or a decrease in collision rate of particles.

Question 4

(a) (i) Only stronger candidates gave a clear, precise definition of the focal point as the point where rays of light, parallel to the principal axis, converge after passing through the lens. Candidates needed to distinguish between the focal length and the focal point. Weaker candidates sometimes mentioned only a single ray of light or said that rays converge, without making it clear that this is after refraction by the lens. Stating that the rays incident on the lens are parallel to the principal axis was a necessary part of the definition of the focal point.

(ii) Candidates needed to know that to produce a magnified image the object must be placed between the focal point and the lens. Candidates who drew an object (usually a vertical arrow) labelled X were given credit. An X that was placed a long distance from the principal axis did not answer the question. Having placed an X on or close to the principal axis between either F_1 or F_2 and the lens, candidates then needed to realise that the virtual image produced would only be visible if viewed through the lens. Therefore E must be on the opposite side of the lens to X. Weaker candidates often placed E in the position where the image would be formed.

(iii) Many candidates correctly described the image in **(ii)** as upright and virtual. Candidates need to read all question carefully. Here, the question instructed them to underline two words, so underlining one word only was insufficient to gain credit.

(b) (i) The majority of candidates correctly calculated the speed of light in glass, using the relationship refractive index of glass equals the ratio of speeds of light in air and glass. Since the data in the question was given to two significant figures, the answer should have been given to two significant figures. Candidates need to be able to rearrange formulae to make any term the subject. In this question, weaker candidates often multiplied speed of light in air by n or omitted the unit in their final answer. A few candidates tried to use the formula $n = \sin i \div \sin r$ to answer this question.

(ii) The strongest candidates correctly stated that the wavelength of light decreases as it enters the glass lens and then linked this change to the lower speed of light in glass. This showed that their answer drew on physics knowledge. A common misconception was to state that the wavelength refracts.

(c) Stronger answers to this question identified long-sightedness as the vision defect that is corrected by a converging lens and then described how the lens corrects this by shortening the overall focal length of the (combined) lens until the light rays converge at the back of the eye (retina). Most candidates also drew diagrams. These helped candidates with weaker expression to gain credit. Many candidates gained credit for knowing what a converging lens does, even if they did not correctly identify the eye defect. A common misconception was to think that long-sightedness is when people see faraway objects less clearly.

Question 5

(a) Only the strongest candidates clearly described that in longitudinal waves vibration is parallel to the direction of travel of the wave and in transverse waves vibration is perpendicular to the direction of travel of the wave. Candidates who described changes in density or pressure, compressions and rarefactions or crests and troughs found these differences in the two types of wave easier to express clearly. Candidates need to learn clear statements about the relation between vibration direction and direction of travel or propagation of wave.

(b) (i) Stronger answers to this question identified the seismic waves as P-waves because they are longitudinal. Candidates needed to read the question carefully as a justification for the type of waves was required and so a simple statement that they were P-waves was insufficient.

(ii) Only stronger candidates used **Fig. 5.1** to identify the distance JK as 1.5 wavelengths and therefore calculated the actual distance as 1.5 × the actual wavelength. Candidates who accurately measured one wavelength and the distance JK both on **Fig. 5.1** and then scaled up these measurements, obtained the correct answer. Candidates need to remember that an answer must always include the unit. Some weaker candidates just measured the distance JK on **Fig. 5.1** and gave this as an answer.

(iii) The strongest candidates showed a clear understanding of the formula $v = f\lambda$ and then calculated the time for one wave using $f = 1 \div T$ before finding the time for 5 oscillations. Candidates benefitted from planning a complex question like this and setting out their calculation in a logical order. An alternative approach used by some candidates was to use $d = s \div t$ and this gave the correct answer if the distance used was the wavelength. A common error was to use the distance value calculated in **(ii)**.

Question 6

(a) (i) A clear definition of electric field includes the idea that it is a region or place where a charge experiences a force. Common insufficient answers described the region where any object experiences a force or the region around a charged object.

(ii) The strongest responses showed an even distribution of at least 4 radial field lines, touching but not extending within the sphere, and with arrows pointing towards the centre of sphere. Candidates need to remember that radial lines must point towards the centre of the sphere, even though the actual line does not extend inside the sphere. Candidates should also take care that all arrows point in the correct direction. Some weaker candidates drew circular field lines around the sphere or patterns looking more like magnetic fields.

(b) (i) To answer this question fully required a statement that electrons were flowing in the wire from the sphere to the Earth. Many candidates provided a sufficient response with the movement of electrons implied and the correct direction indicated by either “from the sphere” or “to the Earth”. Common errors included describing transfer of static charge or the movement of positive charges.

(ii) A small number of candidates were able to get the correct final answer, 2.5 A, by converting time in nanoseconds correctly and substituting values into $I = Q \div t$. Candidates need to be familiar with manipulating numbers in standard form in calculations. Most candidates gained some credit by writing down the correct formula in words or symbols. More credit was given where correct physics led to an answer only different by a power of ten. Candidates need practice at converting nanoseconds to seconds. A few weaker candidates rearranged $Q = It$ incorrectly.

Question 7

(a) The expected definition that electromotive force (e.m.f.) is the work done in moving unit charge around a complete circuit was seen in few responses. Just stating that e.m.f. is the voltage across a battery was insufficient to gain credit. Only the strongest candidates defined e.m.f. in terms of either work done, or energy transferred. A common error was to define e.m.f. as a force. Candidates should be encouraged to learn definitions accurately as well as being able to understand and apply them.

(b) (i) Stronger answers here had neat, accurate drawings of 5 cells in series, with clearly recognisable positive and negative terminals on each cell. The symbol for the variable resistor was clear and the variable resistor and the fixed resistor were in series with the cells. Common errors included confusing a variable resistor symbol with a thermistor symbol and adding lines through components, e.g. wires extending throughout the cells or turning the fixed resistor symbol into a fuse symbol. Candidates need to learn the correct symbols for electrical components given in the syllabus and to include only the components asked for.

(ii) Only a few of the strongest candidates gained full credit here. This required a curve with a decreasing negative gradient starting at a maximum current of 0.25 A at 0 Ω, reaching a minimum current value above zero at 150 Ω. In the strongest answers, candidates used $I = V \div R$ to calculate current values at a couple of key points on the graph. This ensured that their curve touched the *y*-axis at 0.25 A and ensured that it did not touch the *x*-axis. Common errors included graphs not touching the *y*-axis and graphs with a constant gradient. While many candidates used $I = V \div R$, very few substituted in the total resistance to find the current in the series circuit.

Question 8

(a) (i) The majority of candidates showed a good understanding of beta decay and completed a fully correct nuclide equation. Common errors were incorrect values for the proton number and nucleon number for lead (Pb), having written correct notation for the beta particle.

(ii) There were a wide variety of acceptable ways of explaining why γ-emission does not affect the nuclide equation. Most candidates recognised that γ-emission is a wave and has no mass or charge. Candidates needed to be careful not to include a contradictory statement e.g. stating that γ particles are emitted.

(iii) Candidates needed to provide a precise answer explaining that it is an excess of neutrons or the fact that the nucleus is too heavy or contains too many neutrons that makes a particular nucleus unstable. Common insufficient responses were vague and just stated that the nucleus contained a high number of neutrons or was very heavy.

(b) The majority of candidates gained at least some credit in this question with many drawing the path of the γ-radiation undeviated through the magnetic field. The fully correct path of a β-particle was a downwards smooth curve in the magnetic field. Common incorrect paths which gained some credit were smooth curves upwards or a straight-line path downwards and to the right. A few candidates drew paths which were offset, above or below, instead of continuing the beam.

Question 9

(a) Many candidates gained full credit for stating that the Sun emits most energy as infrared, ultraviolet and visible light. Common incorrect regions of the electromagnetic spectrum given were X-rays and gamma radiation. Some weaker candidates listed planets in the Solar System.

(b) Most candidates correctly recalled and rearranged the equation $v = s \div t$, and substituted values to obtain the correct distance. Candidates need to remember that a final answer must always include the correct unit. One common error was to try and use the formula for orbital speed in this question. Another was to use the equation $H_0 = v \div d$. Candidates should always read the question carefully to choose an appropriate formula to use.

(c) (i) Candidates needed to read the whole question for **(c)** and realise that **(i)** and **(ii)** broke down the process of star formation into two separate parts. Candidates expressed the collapse of the cloud in a variety of creditworthy ways, and many attributed this collapse to the effect of gravitational attraction.

(ii) Many candidates wrote coherent answers about how nuclear fusion produces an outwards force which increases as a protostar evolves. The outwards force balances the inwards gravitational force when it is a stable star. A few weaker candidates tried to balance force or energy with pressure, but most candidates were able to name the inwards and outwards forces and identify that they balance in a stable star. Candidates need to be careful when describing fusion. A misspelling of this technical term can lead to ambiguity about whether they mean fusion or fission and ambiguous answers do not gain credit.

PHYSICS

Paper 0625/42
Theory (Extended)

Key messages

Candidates should be reminded to:

- read questions carefully
- apply their knowledge to the particular context of the question
- use correct technical terms and make sure that spelling of these terms is unambiguous
- state the equation they are using in symbols before substituting numerical values
- use symbols given in the syllabus
- give numerical answers to an appropriate number of significant figures with correct rounding of answers
- accurately convert kHz to Hz etc.
- ensure that they include the correct unit in their answer
- set out answers to descriptive questions in a logical order
- ensure that their handwriting is legible and especially that numbers are clear.

General comments

Many candidates showed that they had a wide knowledge across the syllabus. The space physics part of the syllabus was fairly well known but there were gaps in the knowledge of some candidates in this area e.g. Big Bang theory and CMBR.

Most candidates showed their working in calculations and this enabled them to gain partial credit when the final answer was incorrect.

Careful reading of the question and application of knowledge to the specific question was needed in **Questions 2(b)(iii)**, **3(a)**, **4(c)**, **7(b)(i)**, **9(a)(i)** and **9(a)(ii)**.

The use of correct technical terms 'attraction' or 'repulsion' was required in **Question 7(a)** and correct spelling of 'ellipse' or 'elliptical' was needed in **Question 10(b)**.

Attention to correct rounding and giving of answers to an appropriate number of significant figures was needed in **Questions 1(a)**, **3(b)**, **4(b)(i)** and **7(b)(i)**.

Comments on specific questions

Question 1

(a) Most candidates correctly recalled the equation $W = mg$. Many candidates rearranged the equation and substituted values to obtain the correct answer. It is important that candidates round answers correctly. Some weaker candidates gave an answer of 0.08 kg, i.e. an answer correct to only 1 significant figure, possibly confusing significant figures with decimal places.

(b) This question required candidates to use either a scale vector diagram or Pythagoras' theorem and trigonometry. Stronger candidates used an appropriate scale, had arrows in the correct direction on all vectors and measured the correct angle. Stronger candidates who used calculations used Pythagoras correctly and calculated the correct angle using the formula for tan θ. Weaker candidates calculated the angle with the vertical instead of the horizontal, used Pythagoras incorrectly, omitted arrows from vectors or drew the resultant incorrectly or attempted to use cos θ or sin θ rather than tan θ. Candidates should be encouraged to use the values given in the question rather than calculated values wherever possible and should not round their answer before the final answer. This affected those candidates using trigonometry to answer this question. The very weakest candidates omitted this question or simply subtracted forces.

(c) Most candidates gave at least one correct answer to this question. Common correct answers were speed and direction. Weaker candidates gave answers which were secondary effects of forces, e.g. changes of state or temperature or mass/weight or pressure.

Question 2

(a) Many candidates defined acceleration as rate of change of velocity or change of velocity per unit time. The use of both the word 'rate' and 'per unit time' was incorrect.

(b) (i) Candidates needed to use the equation which defined acceleration and rearrange it correctly to give a value for time. Most candidates did this and gave the correct unit. Weaker candidates made mistakes in rearranging the equation or omitted the unit. Some multiplied by the mass, attempting to use all the information given in the question for this part.

(ii) Most candidates correctly recalled the equation $F = ma$. The correct unit for force is N, the derived unit of kg m / s^2 was not an accepted unit.

(iii) Only stronger candidates correctly stated that the force required was greater than the force provided by the train's motors due to the need to overcome friction or air resistance. The question asked about force, so answers referring only to energy changes, heat losses, efficiency did not answer the question.

Question 3

(a) Most candidates were awarded at least partial credit for this question. Stronger answers accurately referred to precise energy transfers between stores. The energy stores were gravitational potential energy, kinetic energy and internal or thermal energy. A reference to sound was also accepted for full credit. Weaker candidates only referred to potential energy instead of gravitational potential energy and there were incomplete or incorrect statements about the energy transfer when the ball hit the ground. The weakest candidates referred to the ball bouncing, despite the question stating that the ball did not bounce, or did not name any energy stores.

(b) Candidates needed to recognise they were required to equate gravitational potential energy lost and kinetic energy gained. Some candidates made mistakes in rearranging the equation or only gave their answer to 1 significant figure. Weaker candidates often tried to use $v = s \div t$, not recognising that the velocity was changing.

Question 4

(a) This question was very well answered by most candidates who gained at least partial credit. Most candidates referred to evaporation happening only on the surface or there being no bubbles present in evaporation. These were alternative ways of expressing the same idea. Weaker candidates gave these as two differences and omitted to state that evaporation does not take place at a specific temperature. Some weaker answers referred to evaporation taking place all the time without relating that to temperature and others stated that there is conversion to a gas in boiling and vapour in evaporation. Reverse arguments about boiling, correctly stated, were also accepted.

(b) (i) Many candidates correctly converted the temperature from °C to K. Candidates needed to understand that absolute zero is a minimum temperature. Weaker candidates gave a negative answer. The most common incorrect answer was –433 K. The value given for absolute zero on the syllabus is –273 °C so candidates were expected to give their answer to 3 significant figures in this question.

(ii) Many candidates gave two correct answers. Weaker candidates gave radiation as one of their answers, showing a lack of understanding of the effect of a vacuum on heat transfer. As the question asked candidates to state two methods of thermal energy transfer, descriptions of conduction or convection did not answer the question.

(c) Most candidates correctly stated that particles collide with the walls of the container. Stronger answers went on to state that those collisions produced a force or a change of momentum on the wall and that pressure = force ÷ area. Weaker candidates omitted a statement that a force was exerted, and some otherwise good answers did not specify the link between pressure and force. It is important that candidates read questions carefully and answer the question that is being asked. Some candidates answered this question in terms of how pressure changes when temperature increases.

Question 5

(a) Stronger candidates answered this question correctly. These answers clearly stated that the ray travels along the normal, at right angles (to the surface) or at an angle of incidence = 0° or that all parts of the wavefront slowed down at the same time. Common weaker answers referred to yellow light or the absence of reflection. Incorrect responses sometimes stated that the ray travels at 90° to normal or angle of incidence = 90°.

(b) (i) Most candidates answered this question correctly. Some candidates only stated the equation $n = \sin i \div \sin r$ which was insufficient to calculate the refractive index with the information given in the question. A few candidates gave the refractive index a unit of ° and the weakest candidates omitted the question or subtracted 42 from 90 and gave an answer of 48.

(ii) Stronger candidates accurately drew a ray with correct reflection and no refraction at BC. Their ray then approached AC at right angles and left AC in the same direction as it approached. Weaker candidates gained only partial credit when they did not draw the angle of reflection equal to the angle of incidence or drew the ray both reflected and refracted or just refracted at BC. Candidates who drew a refracted ray at BC showing refraction away from the normal showed some knowledge of refraction and gained partial credit.

(c) Most candidates could correctly state at least one advantage of using infrared waves in optical fibres to transmit data. Vague answers such as being cheaper, more efficient and accurate were not sufficient for credit and if there was a reference to transparency of the fibres it needed to be transparent to infrared.

Question 6

(a) (i) Stronger candidates gained full credit. The question asked for points to be labelled C and R and the strongest answers showed points and labels. More candidates recognised the correct placement for point C than for point R.

(ii) A few candidates correctly stated that the graph did not show variation of pressure with displacement. Many just repeated words from the question, i.e. stating that it was a pressure–time graph and others stated that it showed a transverse wave and not a longitudinal one.

(iii) Most candidates correctly stated that the amplitude of the sound increases and the frequency of the sound decreases. A common incorrect response was that the frequency remained the same, suggesting a lack of understanding of the relationship between pitch and frequency.

(b) Most candidates gained full credit here. The strongest candidates wrote down the correct equation, rearranged it correctly, calculated the correct value and gave a correct unit. Some candidates either did not convert kHz to Hz or made a mistake in doing so. Some were unable to rearrange the equation correctly and a few gave an answer without a unit or with the unit λ. The weakest candidates did not remember the equation correctly.

(c) Stronger candidates gave a correct answer with a correct unit for the speed of sound in air. Many candidates wrote down the value for the speed of light in air or gave the value given in the question for the speed of sound in a liquid.

Question 7

(a) Most candidates gained at least partial credit. The strongest candidates demonstrated that they knew that the test for magnetism was repulsion and explained clearly and logically how they would test for magnetism with the apparatus they were given. Many candidates gave vague descriptions.

Candidates needed to state clearly that both ends need to be tested for repulsion or attraction. The question stated that no other apparatus was to be used so answers referring to the use of iron filings, another magnet or a compass were not credited. A common misconception was that there would be no force on an unmagnetised piece of steel.

(b) (i) Stronger candidates used the formula $I_pV_p = I_sV_s$, gave numerically correct answers, correctly rounded and with the correct unit, gaining full credit. Candidates needed to realise that it is the fact that the transformer is 100% efficient that allows the use of the formula $I_pV_p = I_sV_s$. Many candidates tried to calculate an efficiency instead of a current. The weakest candidates tried to use the equation relating the number of turns on the primary and secondary coils to the voltage in the primary and secondary coils.

(ii) Stronger candidates drew a neat diagram of a soft-iron core, with coils wound round it with labels of iron core, copper (or other suitable material) coils and the coils also labelled as primary or secondary. Weaker candidates omitted the material used for the coils and did not accurately label the coils.

Question 8

(a) (i) Many candidates placed the correct symbol for a voltmeter in a correct position. Some candidates inserted a thermistor or a variable resistor instead of a voltmeter somewhere in the circuit. Weaker candidates positioned the voltmeter incorrectly, either between the terminals of the power supply or in series with some part of the circuit.

(ii) 1. Many candidates correctly stated that the resistance of the LDR increased.

2. Only the strongest candidates gained credit on this part of the question. Candidates needed to apply their knowledge of how a potential divider works to the context of this question. The p.d. across the fixed resistor + p.d. across the parallel combination (of LDR and LED) equals the e.m.f. of the power source. The equation $V_1 \div V_2 = R_1 \div R_2$ determines how the e.m.f. is shared. When the surroundings become dark, the resistance of the LDR increases. Therefore, the resistance across the parallel combination increases. The application of the equation $V_1 \div V_2 = R_1 \div R_2$ enabled candidates to determine that the p.d. across the LED increases.

Most candidates who attempted this question had several misconceptions. These included statements about the p.d. remaining the same, as the LDR and LED are in parallel, or the p.d. across the parallel combination being that across the power supply. Weaker candidates made references to the p.d. across the LED increasing because V and R are inversely proportional or gave general statements about the behaviour of LEDs, e.g. that the current increased when the brightness increased.

(b) Many candidates gained full credit. Stronger candidates knew that $V = IR$ and that the resistance they calculated, using this equation, was the resistance for the parallel combination, i.e. half the resistance of each bulb. Many candidates divided the resistance of 480 Ω by 2 instead of multiplying it by 2. Some candidates attempted to use the formula for resistors in parallel. They obtained the correct answer if they realised that both resistances were equal. A few candidates omitted the unit or gave an incorrect unit.

Question 9

(a) (i) Many candidates gained at least partial credit. Stronger candidates described safety precautions which were relevant for medical procedures in hospitals. Good explanations explained that increasing distance lowered the amount of radiation reaching staff or that shielding absorbed radiation etc. Responses describing precautions that would be taken in a laboratory did not answer the question. Some candidates named two relevant safety procedures without creditworthy explanations and were given only partial credit for this. Explanations just stating that there would be harm to humans or repeating the safety procedure were insufficient for credit.

(ii) Many candidates were awarded at least partial credit. Stronger candidates stated that alpha particles caused high ionisation and were unable to penetrate the body (and hence could not reach the detector). Weaker candidates referred to general penetration of alpha, e.g. that they can only pass through paper or stated that alpha was more harmful to patients.

(b) Many candidates were awarded full credit for a correct nuclide equation. Most candidates correctly stated the nuclide notation for the beta particle. Weaker candidates were unable to balance proton and nucleon numbers or interchanged some proton or nucleon numbers or added the beta particle to the sodium nucleus. Some candidates reversed the direction of the arrow. The weakest candidates were unable to get any further than writing down the nuclide notation for sodium.

Question 10

(a) Most candidates gave at least one correct answer. Comets and asteroids were the most common correct answers. Weaker candidates gave answers of named planets or moons or satellites. Some candidates referred to dwarfs and omitted the word planets.

(b) Many candidates gave the correct answer. Candidates need to ensure that technical words are spelt correctly. Some weaker candidates confused eclipse with ellipse in this question. A description of an ellipse was acceptable. Some candidates contradicted their answer by referring to circular.

(c) Strong answers required a statement of the energy in the kinetic store decreasing and the energy in the potential store increasing, along with an explanation in terms of conservation of energy. Many candidates correctly stated the energy transfer without any reference to conservation of energy. Weaker candidates suggested a change from potential to kinetic or referred to thermal energy being higher at A due to heat from the Sun.

(d) This question was answered well by most candidates. Good answers stated the correct equation, i.e. $v = s \div t$ and correctly rearranged this to give the time. Some candidates used the orbital velocity equation for a linear distance.

Question 11

(a) Most candidates gave the correct answer. An incomplete answer was the Milky Galaxy. A common incorrect answer was the Solar System.

(b) Stronger candidates gave the correct answer. Common incorrect answers included Haber, Doppler or Hubble.

(c) (i) Many candidates correctly stated that CMBR was formed just after the Big Bang or another similar expression. Answers just stating “Big Bang” without any reference to time were not creditworthy.

(ii) Stronger answers stated that due to expansion of the Universe, redshift had occurred, or the wavelength of the radiation had increased. Weaker candidates made statements about the wavelength of microwave radiation.

PHYSICS

Paper 0625/43
Theory (Extended)

Key messages

Candidates should be reminded to:

- read questions carefully
- answer exactly the question that is being asked (noting the context of the question)
- write clear definitions of key concepts
- write down the equation in symbols or words first
- use symbols given in the syllabus (or clearly define their own symbols)
- round numerical values to the number of significant figures to match given data
- always include the unit with a numerical final answer
- write legibly, taking special care to make number values unambiguous.

General comments

Candidates were generally well prepared for this examination. There was some evidence that weaker candidates found the last three questions challenging, with some making no attempt at any part of **Question 10** or **Question 11**.

When candidates are not sure how to begin a calculation, they should look carefully at the data provided in the question and consider what formulas they know that make use of the data. In **Question 9(b)(ii)**, candidates were given the energy stored, the power of the charger and a time and many candidates wrote down $E = Pt$ to start considering how to answer the question.

In any calculation question, candidates should be encouraged to write down the equation first in symbols or words. In **Question 1(b)** and **Question 4(b)(i)** final answer marks were only awarded if the formula in words or symbols was present.

When quoting a formula in symbols, candidates should use the variables given in the syllabus. Where they use an alternative symbol, it will only be accepted if it is clearly defined by the candidate. Candidates should know that T and θ are acceptable symbols for temperature and t is the symbol for time. E is the symbol for energy and Q is the symbol for charge.

Candidates should always include the unit with a numerical value whether it is the final answer in a calculation or recall of a variable such as the Hubble constant. **Question 7(b)(ii)**, **Question 10(a)(iii)**, **Question 11(b)(i)** and **(ii)** were often given without a unit.

Candidates sometimes had difficulty in expressing key concepts clearly. **Question 1(a)**, **Question 2(c)(i)**, **Question 3(b)(i)**, **Question 6(a)**, **Question 8(a)(i)** and **Question 10(a)(i)** all required clarity in defining key syllabus concepts.

Comments on specific questions

Question 1

(a) Stronger answers stated that deceleration is a decrease in velocity per unit time or a negative rate of change of velocity. Weaker answers which gained some credit stated that deceleration is a decrease in speed or negative acceleration. Candidates needed to be careful to avoid giving a contradictory statement such as “deceleration is decreasing acceleration”.

(b) Where candidates are asked to show that something is true, they must state the equation they use in words or symbols. Manipulating numbers given in a question does not demonstrate understanding of the physics concepts. Some candidates recalled $a = \Delta v \div (\Delta)t$ in words or symbols and used it to show that the ball comes to rest at height h after 1.4 s. Candidates needed to remember that the formula includes the term Δv and not just v.

(c) Candidates chose from several possible methods to answer this question. Equating kinetic energy lost to gravitational potential energy gained, using the formula $s = v_{ave} \times t$ or calculating the area under the speed–time graph were all seen in correct candidate responses. Whichever method candidates used, it was important that they remembered that acceleration and velocity are vector quantities and that the acceleration in this question was $-9.8\,m/s^2$ and the initial velocity was larger than the final velocity.

(d) Stronger answers were well structured, described how the motion of the ball changed and then explained this in terms of the forces acting on the ball. Most candidates gained some credit for stating that the ball accelerates. References to air resistance increasing until terminal velocity is reached and resultant force is zero were common ways of gaining credit. Candidates needed to be careful not to make contradictory statements in their answer such as saying that the ball decelerates or that acceleration increases.

Question 2

(a) Many candidates stated that the energy store in the battery is chemical energy. Candidates needed to know that energy is transferred between stores when electrical work is done but that there is no electrical store of energy.

(b) The strongest answers stated a clear advantage of the parallel connection, e.g. that if one lamp breaks the other branch of the circuit is still complete. Credit was also given for realising that a parallel connection means that both lamps receive the full potential difference of the battery. Candidates needed to avoid statements such as that lamps receive the same voltage which is true but is not an advantage.

(c) (i) Stronger candidates showed understanding that 22% efficiency means that 22% of the total energy produced by the cell was useful energy used to light the lamps. Some candidates wrote this in a sentence and others wrote the efficiency equation, useful power out ÷ total power in = 22%. Common errors included stating that only 22% of the energy produced by the cell was used, or that the energy output from the cell was only 22% of the energy input to the cell.

(ii) Many candidates were able to use the formula for efficiency, rearrange and substitute the useful power output to find the total power input to the cell. Weaker candidates sometimes substituted 15 W as the total power input or were unable to rearrange the efficiency equation correctly.

(d) The strongest candidates recognised that generating electricity where it is used avoids the problems of electricity transmission. Most candidates were able to give at least one advantage. Stronger answers included that there was no need for cables to connect to the mains or that the traffic lights would not be affected by mains power outages.

Question 3

(a) (i) Many candidates explained that the increase in distance of child B from the pivot produced an increase in the clockwise moment. This made the seesaw rotate in the clockwise direction. Weaker candidates often explained the rotation by saying that the force due to child B was greater or that the weight of child B was larger.

(ii) Finding the mass of the backpack involved a complex calculation. Candidates who set out their work in logical steps and used clear notation to distinguish between mass and weight at different stages in the calculation were able to produce a fully correct answer. Many candidates realised that they needed to use moments in some way and those who stated or showed that they were equating moments were able to gain partial credit. Candidates needed to realise that child B was 0.85 m away from the pivot. Some weaker candidates made arithmetical mistakes in adding 0.80 + 0.050 while other candidates used the original distance of child B, from **Fig. 3.1**, in their calculation.

(b) (i) Impulse equals change in momentum or impulse equals force times the time for which the force acts both provided clear definitions of impulse. The strongest answers stated one clear, precise definition. Candidates need to be careful to avoid contradictory answers if they try to give more than one definition. Common misconceptions were that impulse is force over time, a force acting over a period of time or the change in momentum per unit time.

(ii) Stronger candidates stated that force = rate of change of momentum and that the same impulse acted over a longer period of time, so the force exerted on the child was less. Weaker candidates often made vague statements about the floor cushioning the impact or making the child bounce. A common misconception was that the impulse was reduced when the child hit the rubber floor.

Question 4

(a) The majority of candidates gave a correct response, stating either that the kinetic/internal energy of particles increases, or that they move faster. A few candidates gained credit for recognising that the average separation of particles increases.

(b) (i) Many candidates wrote down the formula $\rho = m \div v$ which is used to find the mass of water. Further credit was available for clearly showing the conversion of volume in cm^3 to m^3. Weaker candidates manipulated the numbers given in the question to produce the final answer and then incorrectly formulated the equation for density to fit the numbers, without considering the mixed cm^3 and m^3 terms. Candidates need to read questions carefully and note the unit applied to each numerical value. They should be familiar with how to convert data between different units, such as cm^3 to m^3.

(ii) Many candidates recalled the equation $E = mc\Delta\theta$ and correctly calculated $\Delta\theta$ to find the energy required to increase the water temperature. Candidates should be encouraged to write down the formula they are using in words or symbols first, so that partial credit can be awarded if the final answer is incorrect. Some candidates made arithmetical errors in calculating $\Delta\theta$. Candidates need to know that in a symbol equation Q stands for charge and Δt means change in time.

(iii) The strongest candidates recognised that some of the thermal energy supplied by the heater must be transferred somewhere other than to thermal energy in the water. Common correct responses were thermal energy used to heat the saucepan and thermal energy escaping into the surroundings. Weaker candidates misunderstood the question and suggested changes to the conditions that would make heating the water take longer, such as impurities in the water or altered environmental conditions. Other misconceptions were that it took time for thermal energy to conduct through the metal or that evaporation of water was taking place.

(c) Stronger answers stated clearly that the time to heat the water would increase. These candidates explained this in terms of aluminium's higher specific heat capacity meaning that more thermal energy is needed to raise the temperature of the aluminium per °C. Weaker candidates sometimes incorrectly thought that a higher specific heat capacity reduces the time to heat the water because the saucepan stores more thermal energy.

Question 5

(a) Candidates gained credit for a clear account of how delocalised electrons gain energy from atoms and move throughout the metal colliding with distant atoms to transfer thermal energy throughout the metal. Since the question focused on the role of electrons in thermal energy transfer, there was no credit for references to lattice vibrations or general statements that metals are good conductors. Weaker candidates usually mentioned delocalised or free electrons but often went on to explain the transfer in terms of vibrations rather than movement of electrons through the metal.

(b) Many candidates recognised that it is the lack of delocalised electrons that makes non-metals less good at conducting thermal energy than metals. Common insufficient answers simply stated that non-metals are poor conductors or that non-metals are insulators.

(c) Many candidates explained that gases are poor thermal conductors because the particles in a gas are far apart. This gained some credit. Stronger candidates completed their response by adding that the consequence of this greater particle separation is that collisions which transfer energy are less frequent or that no lattice vibrations take place in a gas.

Question 6

(a) The principal focus is the point where rays of light parallel to the principal axis converge after passing through the lens. Only the strongest candidates included all this detail in their definition. Many more candidates were able to state that the focal length is the distance between the lens and the principal focus. A common misconception about the focal length was that it is the distance from the object to the lens. Weaker candidates struggled to express either definition clearly. A number of candidates made no attempt at this question.

(b) A fully correct answer required careful construction of the image, using a sharp pencil and a ruler and ensuring that lines intended to be parallel to the principal axis were parallel. Many candidates drew two correct rays from the object, extrapolated them back to find the position of the image and then drew and labelled the image of AB. A number of candidates made no attempt at this question.

Question 7

(a) (i) Stronger candidates carefully drew 4 parallel straight lines with a ruler, spaced them evenly and placed an arrow on at least one of them to show the correct direction of the electric field. Candidates needed to take care to avoid uneven spacing of lines. Some weaker candidates concentrated on edge effects or drew field lines outside the gap between the plates.

(ii) The majority of candidates stated clearly that the negatively charged particle is either attracted to the positive plate or repelled from the negative plate. The misconceptions among weaker candidates included references to magnetic effects, electromagnetic induction or gain of electrons and movement in both directions between the plates.

(b) (i) Most candidates recalled and used the equation $I = Q \div t$. Candidates needed to remember that the unit of charge is C, coulomb, to gain full credit. Weaker candidates calculated current divided by time. A number of candidates made no attempt at this question.

(ii) Candidates who identified a correct equation to use, either $E = ItV$ or $V = E \div Q$, usually calculated the numerical answer correctly. Weaker candidates attempted to use $V = IR$ or $P = IV$. Candidates need to remember that a final answer must always include the unit. A significant number of candidates made no attempt at this question.

Question 8

(a) (i) This question asked for a definition of ultrasound, so the strongest answer was that it is sound with a frequency higher than 20 kHz. Stating that it is a sound outside the human hearing range was insufficient as that would also apply to sounds with a frequency below 20 Hz. Many weaker candidates just referred to ultrasound being used to produce images. This suggests they were describing an ultrasound scan rather than defining ultrasound.

(ii) Most candidates knew that the speed of sound in a liquid is greater than the speed of sound in air. Some even gave a correct explanation but that was not required.

(iii) The majority of candidates could correctly state the numerical value of the speed of X-rays in a vacuum. Some candidates wrote the correct numerical value without the unit. Weaker candidates gave random incorrect values or stated that the speed was 0 or the speed of light or a high/fast speed.

(b) This was an open-ended question, asking candidates to describe three similarities or differences between the use of ultrasound and X-rays in scanning procedures. Only stronger candidates gave three valid answers, but more candidates gave two correct responses and many gave one correct response. The most common similarity was that both are used to show the inside of the body. Common differences were that X-rays showed bones or that X-rays are harmful. A few candidates identified that ultrasound pictures are formed due to the reflection of ultrasound waves or that X-ray pictures are formed because X-rays are absorbed by bone. Some statements did not gain credit because they were about the procedure itself, e.g. “ultrasound requires use of a gel”. Other answers did not relate to scanning procedures and compared the properties of X-rays and ultrasound, e.g. that X-rays are transverse and ultrasound is longitudinal.

Question 9

(a) The strongest candidates recognised that this question, although set in the context of charging a mobile phone, was about how a current is produced in the secondary coil of any transformer. These answers contained three elements; the a.c. current produces a changing magnetic field, the secondary coil is in (or cuts) this magnetic field and this causes an induced current in the secondary coil. Weaker candidates often stated that the current from the primary coil travels into the secondary coil when they are in contact. A number of candidates made no attempt at this question.

(b) (i) Few candidates converted kW to W and h to s to show that 0.012 kW h = 4.3×10^4 J. Many candidates made no attempt at this question.

(ii) Candidates needed to use the formula $P = E \div t$ to answer this question. One method was to calculate the energy supplied by the charger in 30 minutes, the value of 50% of the maximum energy stored in the battery and then compare these values to show that more energy is supplied in 30 minutes than is needed to charge the battery to 50%. Another method was to calculate how much energy is needed for 50% charge and then calculate the time taken for the charger to produce this amount of energy and show that it is less than 30 minutes. Many candidates gained some credit in this question with the strongest candidates gaining full credit. Many candidates made no attempt at this question.

Question 10

(a) (i) Stronger answers stated that background radiation is the radiation that is always present, all around us in the environment. Many candidates expressed this well in a wide variety of phrases. Misconceptions included confusing background radiation with count rate and suggesting it was the radiation used to operate the counter.

(ii) Candidates gained credit here for identifying one main source of background radiation from food and drink, cosmic rays, rocks or buildings, or radon gas. Common errors included references to the Sun, suggesting confusion with infrared radiation and stating the ground as a source, perhaps selecting this from **Fig. 10.1**.

(iii) Many candidates correctly subtracted the background count rate from the total count rate shown on the detector to determine the count rate due to the radioactive tracer. Candidates needed to remember to add the unit to the numerical answer. Some candidates omitted the unit.

(b) This question required candidates to apply their knowledge of relative penetrating abilities of alpha, beta and gamma emissions in an unfamiliar context. Most candidates chose either beta or gamma emissions. Stronger candidates were able to state that their choice of beta or gamma was able to penetrate the ground and reach the detector. Only a very few candidates were able to give a reason that distinguished between beta and gamma as a suitable choice. For example, candidates could have suggested that there is a higher count rate where the water is leaking out of the pipe because beta particles are stopped by the pipe.

(c) (i) Stronger candidates stated that an isotope with a short half-life would decay too quickly for the leak to be detected. Common incorrect responses stated that the source would need to be replaced often or that a source with a short half-life was dangerous.

(ii) Only stronger candidates realised that an isotope with a very long half-life would contaminate the water supply. Another good way of expressing this was to say that the water would be hazardous to health if an isotope with a long half-life is used. Vague answers such as that the isotope emits radiation for a long time were insufficient to gain credit.

Question 11

(a) The majority of candidates who attempted this question stated that redshift is the effect that scientists observe in light from distant galaxies. The most frequent incorrect response was to state "Doppler effect". Many candidates made no attempt at this question.

(b) (i) Stronger candidates correctly recalled the numerical value of the Hubble constant. However, many did not include the unit in their answer. A wide variety of incorrect values were seen. Many candidates made no attempt at this question.

(ii) Many candidates gained at least partial credit here by recalling the formula $H_0 = v/d$. Some candidates rearranged the equation and calculated the speed of the galaxy, including the unit with their numerical value to gain full credit. Many candidates made no attempt at this question.

(iii) The strongest answers to this question stated that scientists' measurements show that the more distant galaxies are moving away faster and that this is evidence of the Universe expanding. Weaker candidates often repeated the question by stating that if distant galaxies are moving away from the Earth now, then in the past they must all have been at a single point. Many candidates made no attempt at this question.

PHYSICS

Paper 0625/51
Practical Test

Key messages

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

General comments

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

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

It is assumed that, as far as possible, the IGCSE course will be taught so that candidates undertake regular practical work as an integral part of their study of physics. Questions on experimental techniques were answered much more effectively by candidates who showed evidence of doing similar practical work.

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

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

Comments on specific questions

Question 1

(a) (i) Most candidates recorded a realistic l_0 value although some gave a value that was much too large. This was probably the scale reading at the top or bottom of the spring.

(ii) Many candidates suggested a valid technique. The strongest candidates were able to show the correct use of a set square as a horizontal aid.

(b) Most candidates recorded increasing values of length and calculated the extensions correctly. It was expected that all the lengths and extension values should be given to the nearest mm.

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

(d) Most candidates drew a clear triangle on the graph to show how to obtain the gradient information. A more accurate result is obtained by drawing a large triangle but a significant number of candidates drew a small triangle.

Question 2

(a) Most candidates recorded a realistic current to two decimal places.

(b) Most candidates recorded a realistic potential difference to at least one decimal place and correctly included the units for current and potential difference. The calculations of resistance R_{50} and the ratio r_1 were completed successfully by many candidates. Candidates were expected to deduce the unit for r_1 from the units for R and d.

(c) Candidates carrying out the procedure with care obtained a value for r_2 that was within 10% of r_1.

(d) Candidates were expected to write a statement that matched the results. The justification needed to match both the statement and the results and include the idea of results being within (or beyond) the limits of experimental accuracy.

(e) The symbol for a variable resistor was known by many candidates. However, a common error was to draw the thermistor symbol or a diagram that seemed to be partly thermistor and partly variable resistor.

Question 3

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

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

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

(d) In this question, many candidates needed to read the instruction more carefully to produce values of d and x that were both close to $2f$. Many candidates gave answers that were very far from the accepted range.

(e) The image height h_I should have been equal to h_O within 10%. A significant number of candidates did not achieve this and this was probably due to not moving the screen to the position which gave the clearest focus of the image.

(f) Candidates were expected to suggest a suitable technique such as using a darkened room or a bright object lamp. Moving the screen slowly back and forth to find the clearest image was another sensible suggestion.

Question 4

Candidates who followed the guidance in the question were able to write concisely and covered all necessary points. Some candidates copied the list of apparatus and other information given in the question.

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

Many candidates stated that a metre ruler was required for the investigation.

Candidates needed to identify the variable to be tested. This could have been the load, the length of the composite strip or the number of layers of wood. Having identified the single variable to test, the remaining two variables needed to be kept constant and this needed to be clearly stated.

For the method, candidates needed to add a load to the end of the composite strip and measure the amount of bending. Many realised this could be best done by placing a vertical metre ruler at the end of the strip and recording the depression. Candidates then needed to state that the procedure would be repeated while changing the variable being tested. A vague reference to repeating the experiment was not sufficient as it was not clear whether the test variable had been changed.

Many candidates drew a suitable table. They were expected to include columns for their chosen variable and the depression of the end of the strip with appropriate units.

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

PHYSICS

Paper 0625/52
Practical Test

Key messages

Candidates 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 in advance of the examination date. Where centres wish to substitute apparatus, it is essential to contact Cambridge to check that the change is appropriate and that candidates will not be disadvantaged. Any changes must be recorded in the supervisor’s report.

General comments

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

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

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

The gathering and recording of data presented few problems for any candidates. There was evidence of some candidates not having the use of a calculator. Where calculators are used, candidates should still show their working.

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

Comments on specific questions

Question 1

(a) Most candidates measured and recorded a sensible value for the time taken for 20 oscillations of the suspended mass. A minority of candidates rounded their value for the time taken to 2 significant figures before entering it into the table provided. Timings recorded to at least 3 significant figures were expected here. The calculation of the period T of the oscillations was usually correct. Some candidates inverted the calculation and divided 20 by the time for 20 oscillations. Most candidates stated that the procedure could be improved to increase the accuracy of the result by repeating the timing and calculating an average. Candidates were given credit for this, but the more appropriate answer, of timing more than 20 oscillations of the mass, was much less frequently seen. The calculation of the spring constant k_1 was usually correct and recorded to 2 or 3 significant figures, as required.

(b) This experiment was performed well, with most candidates completing the table to show the stretched length of the spring, as the load on the spring was reduced. However, some candidates rounded their measured stretched lengths of the spring to the nearest whole number of centimetres. This was presumably to make the graph plotting exercise which followed easier. This is not good practice, and candidates should be discouraged from doing this. All values of the stretched length of the spring were expected to be recorded to the nearest millimetre. Graph-plotting skills were of a reasonable standard, but many candidates did not score full credit.

The most common sources of error were:

- Awkward scales, such as 3 or 7 – choosing such scales makes the points much harder to plot and more difficult for plotted points to be checked.
- Choosing scales such that the plotted points did not span at least half of the given grid.
- Forcing the best-fit line to pass through the origin, resulting in an inappropriate line.

If a reading is found to be anomalous when plotting the graph and candidates decide to ignore it when drawing the best-fit line, then that data point should be identified as such on the graph, by circling it, for example. However, there were many excellent, carefully drawn best-fit lines produced. A second value for the spring constant k_2 was usually calculated correctly using the equation provided in the question.

(c) Candidates were asked to state whether their values of k_1 from **(a)(iv)** and k_2 in **(b)(v)** could be considered to be equal within the limits of experimental accuracy, having been told that this is true if their values are within 10 per cent of each other. Many candidates were able to do so.

Question 2

(a) The voltmeter and ammeter readings were nearly always recorded in the table to an appropriate precision. Occasionally, it appeared that some meters were being used on a mA scale with I values well in excess of 100 being recorded in **Table 2.1**.

(b)(c) Most candidates followed the instructions and entered appropriate values for the current and the potential difference across the diode, as the resistance between points X and Y was varied.

(d) The resistance of the diode was usually calculated correctly, but some candidates' responses could not be fully credited as one of their calculated values for the resistance of the diode fell outside the allowed range of $1.0\,\Omega$ to $5.0\,\Omega$.

(e) Stronger candidates used the results they had collected in **Table 2.1** to describe the relationship between the current in the diode, the potential difference across it and the resistance of the diode. Other candidates found it difficult to express, in words, what the numerical values in **Table 2.1** indicated. There were many unclear responses suggesting an increase or decrease which did not link this to any mention of increasing/decreasing current. Responses simply stating that they are directly/inversely proportional also did not gain credit. Many candidates did not answer the question asked, and described the relationships between the potential difference across the diode or the resistance of the diode with resistance between X and Y.

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

(g) Few candidates could identify the name and draw the electrical symbol for the single device which could control the current in the circuit, instead of adding the extra resistors in series. A common incorrect choice was a thermistor. Of those candidates who correctly named a variable resistor/rheostat as the device, many followed this with the symbol for a thermistor.

Question 3

(a) Most candidates followed the instructions and drew a normal to **XY** at point **E**. The measurement of the angle θ between **FE** and the normal was usually measured correctly as 60°, or was within the tolerance allowed. A common incorrect answer was 30°.

(b) Most candidates marked and labelled crosses on the emergent ray from the transparent block and placed their crosses at a distance of 5.0 cm apart, or greater. A few candidates were unaware of the importance of placing their crosses as far apart as possible on the ray trace.

(c) Most candidates followed the instructions, drawing the required lines in the correct positions and producing a ray diagram showing the path of the incident ray through, and emerging from, the transparent block. The required measurements were usually taken correctly and were within the ±1 mm tolerance allowed.

(d) This question asked for a source of inaccuracy in the experiment even when it was carried out very carefully. Answers referring to the block not being correctly placed, ruler inaccuracies or pencil lines being too thick were not appropriate. Common incorrect responses referred to impurities in the block, parallax error and room brightness. Examples of responses which gained credit were reference to the thickness of the light rays, the difficulty in aligning the incident ray with **FE** and the difficulty of placing the crosses accurately on the rays. A minority of candidates referred to optical pins, and the difficulty of working with these, when they had actually used a ray-box to investigate the refraction of light through the block.

(e) The term ‘reproducible’, although explained in the question, was not a term known to many candidates. Many candidates gave descriptions of how to improve the procedure to overcome the inaccuracies mentioned in **(d)**, for example using a thinner slit or repeating and averaging. The most common incorrect response was to repeat the experiment using different angles of incidence. Unfortunately, this would have resulted in a totally different angle of refraction and so a different value for the ratio $d \div l$. Examples of responses which gained credit were “repeat with θ = 60° on the other side of the normal”, “repeat with optical pins” or “turn the block around and repeat”.

(f) The measurements from the diagram were usually present and within the ±1 mm tolerance allowed. The final calculation to find the refractive index of the block was usually performed correctly and the answer given reflected the accuracy with which they had done the drawing and taken the required measurements. Many candidates gave answers which were within the allowed tolerance.

Question 4

The general quality of answers was high. The most comprehensive approach for candidates is to cover each of the bullet points in the question in the order given, beginning with a clear statement of the (independent) variable chosen to investigate. Despite the instruction to do so, many candidates did not state explicitly the variable they had chosen to investigate.

The additional apparatus needed to measure the chosen variable was not always stated. For example, candidates who had chosen to investigate the mass of the ball did not identify the need for both a ruler to measure the dependent variable and a balance to measure the mass. Many candidates listed unnecessary equipment, for example, stand, ruler and clamp, when the question specifically asked for any additional apparatus needed.

Credit for method was gained by most candidates. Candidates needed to state that the ball was placed on the track and released, the dependent variable measured and then the process repeated for a different value of the independent variable.

The choice of control variable was usually correct, with the majority of candidates choosing a control variable which was appropriate to the independent variable.

Tables were usually well set out with appropriate headings and units given. Occasionally, there were missing or incorrect units (e.g. weight / g).

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

Candidates were able to score the final credit by making one of three additional points in their answers. They could have given a second valid control variable or could have stated that at least five sets of data should be taken, or could have stated that each measurement should be repeated and an average taken. Statements such as “repeat the experiment” or “repeat and average” were too vague to gain credit unless it was clear that these ‘repeats’ were being carried out for each (or the same) value of the independent variable.

PHYSICS

Paper 0625/53
Practical Test

Key messages

Candidates need to have a thorough understanding of practical work during the course and should have had significant experience in actually carrying out experiments themselves. This should include what is needed to improve reliability in experimental work and how to identify which variables need to be controlled.

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

Direct measurements should always be taken to the relevant accuracy, with calculations stated to the required, and consistent, number of significant figures, or decimal places. Clear working, with the correct units, should always be shown. These techniques will be tested in the paper. The use of fractions is not allowed.

All questions should be read carefully so that candidates understand what is being asked clearly so that appropriate responses can always be given.

General comments

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

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

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

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

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

Comments on specific questions

Question 1

(a) (i) Most candidates gave suitable answers.

(ii) Most candidates calculated a correct value for V_A.

(b) Some candidates gained partial credit for identifying a problem with accurately measuring the dimensions but very few gained full credit. Many just duplicated an answer from **(e)** and **(f)**.

(c) Most candidates correctly measured the mass.

(d) Many candidates carried out the correct calculation, with some omitting the units.

(e) Most candidates correctly measured the weight.

(f) (i) Most candidates correctly measured both volumes.

(ii) Most candidates identified the correct line of sight.

(g) There were many correct calculations.

Question 2

(a) Most candidates correctly read the temperatures over the 180 s.

(b) (i) Most candidates scored full credit.

(ii) Most candidates gained credit but there were a few who did not give any response.

(c) Most candidates made a correct statement about the cooling rates and many referred to a comparison of cooling rates.

(d) (i) Many correct calculations were seen but sometimes the units were missing.

(ii) There were many correct calculations seen.

(iii) There were very few correct answers seen.

(e) Most candidates scored at least partial credit.

Question 3

(a) (i) Most candidates correctly measured h_O.

(ii) Most candidates filled in the table correctly.

(iii) Many correct answers were seen but some candidates just said ‘move’ rather than ‘move slowly’.

(b) Most candidates calculated the values of W.

(c) Most axes were labelled correctly with extremely few being reversed. Many appropriate scales were seen with some candidates starting their scale at (0, 0) which resulted in a graph which was too small. Actual readings used as an equidistant scale were not acceptable. There were very few awkward scales seen e.g., 3’s or 7’s. Points were almost always correctly plotted. Candidates should know that the plots on a graph should be precise and not blobs, crosses being the most appropriate way of plotting the points. Many good lines were drawn but candidates should not assume that the graph will always pass through (0, 0).

(d) (i) Evidence of having used the graph was shown by many candidates.

(ii) Many candidates did not gain credit here either because their answer fell out of range or was not answered to 2 or 3 significant figures.

(e) Very few candidates identified that h_I would be very small or that it would be hard to measure.

Question 4

Most candidates identified that an ammeter and voltmeter were the additional apparatus required and many correctly connected them to complete the circuit using appropriate symbols.

Most candidates showed how to measure the p.d. and current but omitted to repeat the experiment with different diameter wires. Many candidates stated that the length of the wire was the control variable. The table often showed correct quantities and units. The most common method for comparing results was by means of a graph, with the axes stated.

It is suggested that after completing this question, candidates read through their response and see if their planned experiment matches the asked investigation.

PHYSICS

Paper 0625/61
Alternative to Practical

Key messages

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

General comments

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

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

It is assumed that, as far as possible, the IGCSE course will be taught so that candidates undertake regular practical work as an integral part of their study of physics. Questions on experimental techniques were answered much more effectively by candidates who showed evidence of having regular experience of similar practical work. Some candidates appeared to have learned sections from the mark schemes of past papers and produced responses that were not appropriate to the questions in front of them.

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

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

Comments on specific questions

Question 1

(a) Many candidates suggested a valid technique. Stronger candidates were able to show the correct use of a set square as a horizontal aid.

(b) Most candidates recorded the correct value, 21.6, in the table.

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

(d) Most candidates drew a clear triangle on the graph to show how to obtain the gradient information. A more accurate result was obtained by drawing a large triangle, but a significant number of candidates drew a small triangle.

(e) Here candidates were expected to record k as numerically equal to G and give the value to two or three significant figures, adding the unit N / cm. Some candidates omitted the unit.

Question 2

(a) (i) Many candidates correctly recorded the current and potential difference readings. Some did not study the scales with sufficient care to work out the size of the scale divisions.

(ii) The calculation of resistance R_{50} was completed successfully by many candidates. Many candidates also gave the correct unit.

(iii) The calculation of r_1 was completed successfully by many candidates. Candidates were expected to deduce the unit for r_1 from the units for R and d.

(b) (i) Candidates were expected to write a statement that matched the results. The justification needed to match both the statement and the results and include the idea of results being within (or beyond) the limits of experimental accuracy.

(ii) Candidates were expected to suggest at least three additional values for the initial credit. Further credit was awarded to candidates who gave all the suggested values within a range appropriate to apparatus that would be used in the school laboratory, i.e. values greater than 0 and up to 100 cm.

(c) The symbol for a variable resistor was known by many candidates. However, a common error was to draw the thermistor symbol or a diagram that seemed to be partly thermistor and partly variable resistor.

Question 3

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

(b) (i) Candidates were expected to give the x value to the nearest mm. However, many candidates wrote 2 cm.

(ii) The calculation of the scale ratio r was completed successfully by most candidates. An answer to two or three significant figures was expected.

(c) Similarly, both parts of this question were completed successfully by most candidates.

(d) Candidates were expected to calculate the focal length and to give the answer to two or three significant figures as suitable for this type of experiment. Some candidates found this question challenging.

(e) Candidates were expected to suggest two suitable techniques such as using a darkened room (or a bright object lamp) and moving the screen slowly back and forth to find the clearest image. Many candidates gave at least one creditworthy suggestion.

(f) Candidates needed to draw upon their practical experience to answer this question. It was evident that many candidates had not seen the image produced in such experiments and did not realise that the image would appear upside down. Stronger candidates drew a suitable image.

Question 4

Candidates who followed the guidance in the question were able to write concisely and covered all necessary points. Some candidates copied the list of apparatus and other information given in the question.

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

Many candidates stated that a metre ruler was required for the investigation.

Candidates needed to identify the variable to be tested. This could have been the load, the length of the composite strip or the number of layers of wood. Having identified the single variable to test, the remaining two variables needed to be kept constant and this needed to be clearly stated.

For the method, candidates needed to add a load to the end of the composite strip and measure the amount of bending. Many realised this could be best done by placing a vertical metre ruler at the end of the strip and recording the depression. Candidates then needed to state that the procedure would be repeated while changing the variable being tested. A vague reference to repeating the experiment was not sufficient as it was not clear whether the test variable had been changed.

Many candidates drew a suitable table. They were expected to include columns for their chosen variable and the depression of the end of the strip with appropriate units.

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

PHYSICS

Paper 0625/62
Alternative to Practical

Key messages

Candidates should have as much personal experience of carrying out experiments themselves as possible. The practical work should include reflection upon, and the discussion of the significance of results, precautions taken to improve reliability and control of variables.

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

General comments

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

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

The majority of candidates were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. Most candidates were able to follow instructions correctly, record observations clearly and perform calculations accurately and correctly. Units were well known and were almost always included. Writing was neat and legible and ideas were expressed logically. However, many candidates seemed less able to reach conclusions backed up by evidence, or to present well thought out conclusions.

The vast majority of candidates finished the paper and few candidates left a significant number of questions unanswered. Some candidates 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) The reading on the stop-watch, 17.76 s, was recorded correctly by the majority of candidates. Common incorrect answers were 17, 17.7, 18 and 17:76. The calculation of the period *T* of the oscillations was usually correct. Some candidates inverted the calculation and divided 20 by the time for 20 oscillations.

(b) Most candidates stated that the procedure could be improved to increase the accuracy of the result by repeating the timing and calculating an average. Candidates were given credit for this, but the more appropriate answer, of timing more than 20 oscillations of the mass, was much less frequently seen.

(c) The calculation of the spring constant k_1 was usually correct.

(d) The stretched length of the spring, 5.6 cm, was nearly always measured correctly from the diagram in **Fig. 1.3**, and its value recorded to the nearest millimetre. Answers given to 3 significant figures, e.g. 5.60 cm, were not accepted. Candidates were told that **Fig. 1.3** had been drawn to a scale of one-quarter full size. The calculation of the actual length of the spring proved to be challenging for many weaker candidates. They often divided their measurement of 5.6 by 4, instead of multiplying, and others wrote down, without showing any calculation, incorrect answers which had no obvious relationship to 5.6 or 4.

(e) Graph-plotting skills were of a reasonable standard, but many responses did not score full credit.

The most common sources of error were:
- Awkward scales, such as 3 or 7 – choosing such scales makes the points much harder to plot and more difficult for plotted points to be checked.
- Choosing scales such that the plotted points did not span at least half of the given grid.
- Forcing the best-fit line to pass through the origin, resulting in an inappropriate line.

If a reading is found to be anomalous when plotting the graph and candidates decide to ignore it when drawing the best-fit line, then that data point should be identified as such on the graph, by circling it, for example. However, there were many excellent, carefully drawn, best-fit lines produced. A second value for the spring constant k_2 was usually calculated correctly using the equation provided in the question.

(f) Candidates were asked to state whether their values of k_1 from **(c)** and k_2 in **(e)(iii)** could be considered to be equal within the limits of experimental accuracy, having been told that this is true if their values are within 10 per cent of each other. Many candidates were able to do so.

Question 2

(a) Most candidates recorded the correct values for the voltmeter and ammeter readings in **Table 2.1**.

(b) The resistance of the diode, calculated from candidates' readings in **(a)**, was usually correct. Most candidates recorded their answers to the 2 significant figures expected but there were some incorrectly rounded answers here.

(c) The remaining calculations of the missing values of resistance and current in the table were usually correct.

(d) Stronger candidates used the results they had collected in **Table 2.1** to describe the relationship between the current in the diode, the potential difference across it and the resistance of the diode. Other candidates found it difficult to express, in words, what the numerical values in **Table 2.1** indicated. There were many unclear responses suggesting an increase or decrease which did not link this to any mention of increasing/decreasing current. Responses simply stating that they are directly/inversely proportional also did not gain credit. Many candidates did not answer the question asked, and described the relationships between the potential difference across the diode or the resistance of the diode with resistance between X and Y.

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

(f) Few candidates could identify the name and draw the electrical symbol for the single device which could control the current in the circuit, instead of adding the extra resistors in series. A common incorrect choice was a thermistor. Of those candidates who correctly named a variable resistor/rheostat as the device, many followed this with the symbol for a thermistor.

Question 3

(a) Most candidates followed the instructions and drew a normal to **AB** at point **E**, but sometimes the required labels **N**, **M** and **G** were missing. The measurement of the angle θ between **FE** and **EN** was usually measured correctly as 60°, or was within the tolerance allowed. A common incorrect answer was 30°.

(b) Most candidates followed the instructions, drawing the required lines in the correct positions and producing a ray diagram showing the path of the incident ray through, and emerging from, the transparent block. The lines **FZ** and **EH** were nearly always present, with **H** and **Z** labelled. The line **FZ** was often not extended to the right-hand edge of the ray-trace sheet, as requested.

(c) The required measurements were usually taken correctly and were within the ±1 mm tolerance allowed. The ratio $d \div l$ was almost always calculated correctly but was often outside the allowed range. The value of the ratio provided an indication of the accuracy with which candidates had drawn and measured the lines on their constructions.

(d) The term ‘reproducible’, although explained in the question, was not a term known to many candidates. Many candidates gave descriptions of how to improve the procedure to overcome the inaccuracies mentioned in **(e)**, for example using a thinner slit or repeating and averaging. The most common incorrect response was to repeat using different angles of incidence. Unfortunately, this would have resulted in a totally different angle of refraction and so a different value for the ratio $d \div l$. Examples of responses which gained credit were “repeat with θ = 60° on the other side of the normal”, “repeat with optical pins” or “turn the block around and repeat”.

(e) This question asked for a source of inaccuracy in the experiment even when it was carried out very carefully. Answers referring to the block not being correctly placed, ruler inaccuracies or pencil lines being too thick were not appropriate. Common incorrect responses referred to impurities in the block, parallax error and room brightness. Examples of responses which gained credit were reference to the thickness of the light rays, the difficulty in aligning the incident ray with **FE** and the difficulty of placing the crosses accurately on the rays. A few candidates referred to optical pins, and the difficulty of working with these, when they had actually used a ray-box to investigate the refraction of light through the block.

(f) The measurements from the diagram were usually present and within the ±1 mm tolerance allowed. The final calculation to find the refractive index of the block was usually performed correctly and the answer given reflected the accuracy with which they had done the drawing and taken the required measurements. Many candidates gave answers which were within the allowed tolerance.

Question 4

The general quality of answers was high. The most comprehensive approach for candidates is to cover each of the bullet points in the question in the order given, beginning with a clear statement of the (independent) variable chosen to investigate. Despite the instruction to do so, many candidates did not state explicitly the variable they had chosen to investigate.

The additional apparatus needed to measure the chosen variable was not always stated. For example, candidates who had chosen to investigate the mass of the ball did not identify the need for both a ruler to measure the dependent variable and a balance to measure the mass. Many candidates listed unnecessary equipment, for example, stand, ruler and clamp, when the question specifically asked for any additional apparatus needed.

Credit for method was gained by most candidates. Candidates needed to state that the ball was placed on the track and released, the dependent variable measured and then the process repeated for a different value of the independent variable.

The choice of control variable was usually correct, with the majority of candidates choosing a control variable which was appropriate to the independent variable.

Tables were usually well set out with appropriate headings and units given. Occasionally, there were missing or incorrect units (e.g. weight / g).

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

Candidates were able to score the final credit by making one of three additional points in their answers. They could have given a second valid control variable, or could have stated that at least five sets of data should be taken, or could have stated that each measurement should be repeated and an average taken. Statements such as “repeat the experiment” or “repeat and average” were too vague to gain credit unless it was clear that these ‘repeats’ were being carried out for each (or the same) value of the independent variable.

PHYSICS

Paper 0625/63
Alternative to Practical

Key messages

Candidates need to have a thorough understanding of practical work during the course and should have had significant experience in actually carrying out experiments themselves. This should include what is needed to improve reliability in experimental work and how to identify which variables need to be controlled.

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

Direct measurements should always be taken to the relevant accuracy, with calculations stated to the required, and consistent, number of significant figures, or decimal places. Clear working, with the correct units, should always be shown. These techniques will be tested in the paper. The use of fractions is not allowed.

All questions should be read carefully so that candidates understand what is being asked clearly so that appropriate responses can always be given.

General comments

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

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

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

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

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

Comments on specific questions

Question 1

(a) (i) Many candidates did not give all three measurements to the nearest mm e.g. gave w = 3 not 3.0.

(ii) Most candidates correctly calculated V_A.

(b) Some candidates gained partial credit for identifying a problem with accurately measuring the dimensions but very few gained full credit. Many just duplicated an answer from **(e)** and **(f)**.

(c) Most candidates correctly calculated the density but some gave the wrong unit or omitted one entirely.

(d) Most candidates correctly read the scale with a very few giving the answer as 3.5.

(e) (i) Most candidates correctly read the scale.

(ii) Many candidates gave a correct answer.

(f) (i) Many candidates made the correct calculation.

(ii) There were very few reasonable suggestions given by candidates.

Question 2

(a) Most candidates correctly read the thermometer as 18 °C with a few reading it as 10.8 °C.

(b) (i) Most candidates scored at least partial credit.

(ii) Many candidates gained credit but there were quite a few candidates who did not give any response.

(c) Most candidates made a correct statement about the cooling rates and many referred to a comparison of cooling rates.

(d) (i) Many correct calculations were seen but sometimes the units were missing.

(ii) There were very few clear responses to this question.

(e) Most candidates scored at least partial credit.

Question 3

(a) Many correct answers were seen but some candidates just said ‘move’ rather than ‘move slowly’.

(b) (i) Several candidates did not give h_O to the nearest mm.

(ii) Most calculations were done correctly.

(c) Most axes were labelled correctly with extremely few being reversed. Many appropriate scales were seen with some candidates starting their scale at (0, 0) which resulted in a graph which was too small. Actual readings used as an equidistant scale was not acceptable. There were very few awkward scales seen e.g., 3’s or 7’s. Points were almost always correctly plotted. Candidates should know that the plots on a graph should be precise and not blobs, crosses being the most appropriate way of plotting the points. Many good lines were drawn but candidates should not assume that the graph will always pass through (0, 0).

(d) (i) Evidence of having used the graph was shown by many candidates.

(ii) Many candidates did not gain credit because their answer fell out of range or it was not answered to 2 or 3 significant figures.

(e) Very few candidates identified that h_I would be very small or that it would be hard to measure.

Question 4

Most candidates identified that an ammeter and voltmeter would be the additional apparatus required and correctly connected them to complete the circuit using appropriate symbols.

Many candidates stated that the length of the wire was the control variable. The table often showed correct quantities and units. The most common method for comparing results was by means of a graph, with the axes stated.

It is suggested that after completing this question, candidates read through their response and see if their planned experiment matches the asked investigation.