PHYSICS

Paper 0625/11
Multiple Choice (Core)

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

General comments

Many candidates performed well across the paper and showed a good understanding of the syllabus.

Comments on specific questions

Question 1

Option **D** was the most common incorrect answer. These candidates possibly felt that the reference to something being digital made it more accurate. The fact is that calculators perform calculations accurately, but they cannot correct for poor data being entered into them. The correct technique is to measure many times and divide by the number being measured, as specified in Syllabus Section 1.1.3.

Question 2

Most candidates selected the correct response for this question and showed a secure understanding of the idea of deceleration.

Question 4

A majority of candidates answered correctly. The most popular incorrect option was **B**. This was possibly due to these candidates believing that a weighing device measures mass, whereas, in fact, a spring balance (properly called a newton-meter) measures force, even though it may have a scale expressed in kilograms.

Question 5

Many candidates had a good understanding on the transfer of energy between the kinetic and gravitational potential stores.

Question 9

Many candidates incorrectly thought that geothermal isn’t renewable. In the very long term, all sources will vanish (or become irrelevant) when the Earth is swallowed up during the Red Giant phase of the Sun’s life cycle. However, in the medium-term geothermal energy comes from the decay of radioisotopes that will outlive the earth and, therefore, will keep providing for as long as we like. On the other hand, fossil fuels (including natural gas, the correct answer) were formed during a finite epoch and will run out quite soon.

Question 10

Many candidates forgot to convert the time into seconds, but all coped with ‘k’ as a multiplier. Few candidates knew that they needed to both divide energy by time and convert the units.

Question 15

Most candidates were able to answer this question successfully.

Question 25

This question was challenging for many candidates. In the second diagram, the downward force on the balance is reduced, which means that object 2 is attracting object 1 and is, therefore positively charged. To decrease the balance reading yet further we need a bigger difference of charge on the two objects. So we would like object 1 to acquire extra electrons and /or object 2 to lose more electrons, and **D** obviously fulfils this requirement, while **C** (by far the most popular option) has the opposite effect. Options **A** and **B** are not so easy to deal with without some mathematics, but it is reasonably easy to see that if sufficient electrons are added or removed, one or other of the objects will have its charge reduced to zero, and there will then be no reduction of the balance reading at all.

Question 29

Many candidates found this question on electricity quite challenging. Many treated the resistors as if they were in series, and just summed the values. Stronger candidates usually answered correctly.

Question 31

The most popular option here was **B**, indicating that candidates thought of electromagnetic induction exclusively in terms of conductors and fields being in relative motion, and ignored the approach that focuses on a change in the magnetic flux linkage, as specified in section 4.5.1.1 of the syllabus, that is exemplified in diagram Q.

Question 38

Some weaker candidates did not know the order of the planets.

PHYSICS

Paper 0625/12
Multiple Choice (Core)

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

General comments

Many candidates performed well across the paper and showed a good understanding of the syllabus.

Comments on specific questions

Question 3

The most popular choice was **D**, which was the distance travelled between t = 4 s and t = 7 s. This was incorrect. The question asked for the distance travelled during the last three seconds of the athlete's acceleration, i.e. between t = 1 s and t = 4 s. Of those candidates who recognised that the acceleration period was crucial, most calculated the acceleration during the whole of the 4 s period.

Question 4

Many candidates knew the relationship between 590 N and 60 kg, but misidentified the former as the mass and the latter as the weight, and so chose option **D**.

Question 5

The syllabus defines density as 'mass per unit volume'. Many candidates selected option **A** indicating that many thought that 'per' means 'multiplied by' rather than 'divided by', in spite of the equation immediately following the definition.

Question 10

The most popular incorrect response was option **C**, chosen by candidates who had forgotten that times must usually be converted to seconds before being substituted into formulae. Most candidates multiplied 8 by 180, clearly just trying any combination of the numbers in the question that would give an answer in the list.

Question 14

Most candidates answered this correctly.

Question 15

Most candidates showed a good understanding of the vocabulary of changes of state.

Question 17

All options were popular indicating that most candidates did not know the difference between transverse and longitudinal waves and were not familiar with simple examples of the two types.

Question 19

More candidates chose option **A** than the correct option (**D**), indicating that they had probably learned the ROYGBIV mnemonic by rote, without recognising that red light has a lower frequency and a higher wavelength than violet light (as specified in Syllabus Section 3.2.4.2).

Question 21

Some candidates selected option **A** or **C**, which have neither the largest value of x nor the largest value of y.

Question 22

This question was answered well by stronger candidates, but weaker candidates thought that all electromagnetic waves travel at the same speed in water.

Question 25

Option **B** was slightly more popular than option **C**, the correct answer. It was clear that Kirchhoff's Laws were challenging for many candidates.

Question 31

Only stronger candidates knew what a.c. means, with most other candidates choosing option **A**, in spite of the current being positive at all times.

Question 37

Many candidates selected option **C** which was incorrect.

PHYSICS

Paper 0625/13
Multiple Choice (Core)

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

General comments

Many candidates performed well across the paper and showed a good understanding of the syllabus.

Comments on specific questions

Question 2

Most candidate answered this correctly. Option **D** was a common incorrect choice but was wrong for two reasons. Firstly statement 3 could only be true if the horizontal line of the graph were to pass through the zero on the speed axis and secondly, statement 1 was true because the graph then tells us that the train is at a constant distance from the station as time passes and is therefore at rest.

Question 9

This was challenging for many candidates. The syllabus specifies a list of sources in Section 1.7.3.1 and then that candidates should know which of those sources are renewable. There were two difficult resources in the list for this question. The first of these was geothermal resources which is regarded as renewable because it arises from the radioactive decay of elements in the Earth's core, and which have lifetimes longer than the expected main sequence phase of the Sun's evolution. The second was nuclear fuel, which we regard as non-renewable since the chemicals required are only accessible in the Earth's crust, which is a very small proportion of the mass of the planet, and it is easy to conceive that all of the accessible fuel will be mined in a relatively short period. However, candidates who thought that nuclear energy is renewable should have selected **D**, which few candidates did. The most popular responses were options **A** and **B**.

Question 13

Many candidates chose option **A**, indicating that high pressure goes with high volume, and most other candidates chose option **B**, thinking that the pressure does not change as the gas is compressed or expanded. Syllabus statement 2.1.3.1 states that candidates should know how the pressure changes as the volume changes.

Question 15

Option **A** was the most popular choice, whereas Syllabus statement 2.2.3.1 states quite clearly that there is no temperature change during melting.

Question 16

Option **C** was the most popular choice here, probably because candidates did not notice from the diagram that the gap is labelled as being below the cupboard.

Question 19

Option **A** was the most popular choice, probably because candidates are used to seeing this diagram the other way up.

Question 20

Some candidates knew that the angle of reflection is measured between the ray and the normal. Most candidates selected option **A** rather than **B**.

Question 27

Most candidates answered this question correctly, but the weaker ones thought that resistance is measured in amps.

Question 30

This question was challenging for many candidates. The fuse is to protect the next section of the cable, so any fuse up to 15 A would be acceptable. However, since the heater takes 5 A (which is acceptable for the cable) a 4 A fuse would melt. Therefore, the 10 A fuse is the one to choose in this situation.

Question 36

A substantial number of candidates chose option **B** and were unaware that beta decay changes the substance into a different element, as specified in syllabus section 5.2.3.2.

PHYSICS

Paper 0625/21
Multiple Choice (Extended)

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

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

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

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

General comments

Many candidates performed well across the paper and showed a good understanding of the syllabus.

Comments on specific questions

Question 2

Almost all candidates knew what deceleration is and were able to identify option **D** as the correct response.

Question 5

More candidates selected option **D** than the correct answer here. The parachutist is descending at terminal, that is, constant speed. Thus, the acceleration is zero, which means that the resultant force must be zero as well. On the other hand the velocity of the aircraft in option **B** is continually changing (because its direction is changing even though its magnitude remains the same), and so the aircraft is accelerating. This means that it must have a resultant force on it, known as a centripetal force.

Question 6

Some candidates answered this correctly. Hardly any candidates chose option **D**, indicating that candidates had a good understanding of the graphical representation of the magnitude of a vector.

Question 10

Many stronger candidates chose the correct answer.

Question 13

Most candidates chose option **B**. In this question, the gas gets hotter, so its molecules move more quickly. Each molecule therefore has more momentum when it strikes the piston, so the change of momentum at each collision is increased. But the pressure at the piston has not changed, and the area of the piston has not changed, so the overall force exerted on the piston has not changed either, which means that the total momentum change per unit time has not changed. If the momentum change delivered by each collision has increased, there must be fewer of them each second, so the frequency decreases (Option **A**).

Question 19

Syllabus Section 3.2.3.6 specifies that candidates should be able to complete such ray diagrams, so a good strategy would have been to sketch the other rays onto the question paper and notice that since both of the rays added point down and to the right, option **A** is the only possible option.

Question 23

Stronger candidates answered this correctly while weaker candidates often chose choose **A**.

Question 25

This question related to Syllabus Section 4.2.1.9 but only the strongest candidates answered this correctly.

Question 26

Nearly all candidates got this question right.

Question 28

Only stronger candidates knew which way the electrons move.

Question 36

In this question, candidates needed to recognise that while they may be used to determining half-lives from a decay curve, here they had to realise that the atoms present are all either of nuclide X or of nuclide Y and the total number of atoms remains constant. Therefore, the graph for the mass of X against time is an upside-down version of the graph given. The result then follows.

Question 37

Only stronger candidates were aware that the absorption of a neutron triggers fission.

PHYSICS

Paper 0625/22
Multiple Choice (Extended)

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

General comments

Many candidates performed well across the paper and showed a good understanding of the syllabus.

Comments on specific questions

Question 6

This question was answered extremely well. Only the weakest candidates were distracted by option **A** in which the resultant force is zero, but the resultant moment is not.

Question 7

Many candidates were successful here, but weaker candidates found it difficult to understand the ideas of impulse and momentum.

Question 9

The most common response was option **B**, which took no account of the work done against friction. The right approach was to calculate the loss in gravitational potential energy using the weight and the height, and then to argue that this appears as kinetic energy, but only after subtracting the 10 J lost to friction.

Question 13

Dealing with reciprocals and inverse proportion is a high-level skill, and only the strongest candidates succeeded in answering this correctly.

Question 27

The most common choice was option **B**. Candidates who chose this may have thought that resistance is the gradient of the current-potential difference characteristic as this is a common misconception. Resistance is actually found by dividing the potential difference by the current.

Question 31

The strongest candidates answered this correctly, but others found it difficult to navigate. A number of approaches were possible. One of which is this: in the initial scenario, the information in syllabus section 4.5.1.4 (sometimes known as Lenz's Law) tells us that X becomes an S pole to try to pull the magnet back to where it was. Similarly in the second scenario, Y becomes an N pole in order to repel the N pole of the approaching magnet, again to preserve things as they were. The polarities of X and Y are the same in each of these scenarios, so the induced currents causing them must be in the same direction.

Question 36

Only stronger candidates answered this correctly. These candidates concentrated on the first and last columns in the table, which are 2 half-lives apart. One approach was trial and error. For example, if the background were 15 counts/s, the initial activity due to the source would have been 385 counts/s, so after two half-lives the count rate due to the source would be 96 count/s which, added to the presumed background, would result in a total count rate of 111 counts/s. This approach discounted this as an option. An alternative approach was algebraic, letting s be the final rate due to the source, and b be the background rate. Then we have $4s + b = 400$ counts/s and $s + b = 115$ counts/s, from which simultaneous equations b may readily be found.

PHYSICS

Paper 0625/23
Multiple Choice (Extended)

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

General comments

Many candidates performed well across the paper and showed a good understanding of the syllabus.

Comments on specific questions

Question 8

Candidates who answered incorrectly were equally divided between options **B** and **C**, indicating that these candidates had not recognised that when the mass is at its lowest point, it is just turning round and so is neither moving up nor moving down.

Question 12

Many candidates thought that the average separation of the particles would increase, in spite of the volume of gas remaining unchanged.

Question 13

Stronger candidates answered this more challenging question well. The most popular incorrect option was option **B**.

Question 14

P will always occur. If the water is cooler than the temperature of the student's face then Q and R will occur simultaneously as well. As ‘P only’ is not an option, the only possible answer is option **D**, in which all three occur.

Question 15

This proved to be a challenging question for many candidates. Most candidates selected option **A**, in spite of **A** and **D** both being situations in which the surface area exposed to the atmosphere remains the same.

Question 17

Only stronger candidates answered this correctly. The question referred to the sharpest image, implying the least blurring, and that this in turn implies the least diffraction. Candidates then needed to know that little diffraction implies a short wavelength and a large aperture.

Question 20

Most weaker candidates chose option **A**, forgetting that the angles of incidence have to be measured from the normal, and that the angle of incidence is not therefore shown on the diagram, and has to be calculated from the 35° angle that is shown.

Question 22

Many candidates simply divided the angle of incidence by the refractive index rather than working through the sines. Presumably these candidates were merely looking for a combination of the data given that would produce one of the responses.

Question 28

If the teacher holds a metal rod, then any charge she manages to generate will instantly be conducted to earth. Option **B** is the only option with two insulators.

Question 29

Most candidates recognised that options **A** and **C** have different units on each side of the equation, and so could not possibly be true.

Question 30

Many candidates found this question very challenging. When the brightness is increased, the resistance of the LDR goes down. That means that its share of the overall pd goes down too, so option **A** is the answer.

Question 31

Many candidates answered this correctly, but some candidates chose option **C**, showing that they had not recognised that moving a wire more quickly in a magnetic field induces a greater e.m.f.

Question 33

Some candidates thought that a transformer converts d.c. to a.c.

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.

Some of the candidates' handwriting made it difficult to distinguish what they were writing. There were clear issues differentiating between 1's and 7's, 4's and 7's, 6's and 0's, 9's and 0's, 9's and 4's, 7's and 9's. Centres should encourage candidates to ensure that working and answers to numerical questions are as clear as possible.

General comments

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

Candidates should ensure that they make it clear in their answers what they are referring to. On some occasions it was unclear what the pronouns 'it' or 'they' were referencing. Similarly, candidates frequently stated a property had changed but failed to state how it had changed i.e. increased/decreased. Candidates should be encouraged to use more precise language.

Comments on specific questions

Question 1

(a) (i) Most candidates correctly determined the distance travelled in the first 100 seconds.

(ii) Most candidates correctly determined the speed during the first 100 seconds on the speed-time graph. The most common error was to substitute incorrect values from the graph.

(iii) Candidates found this item challenging and only the strongest candidates gained full credit. The most common error was to confuse this distance-time graph with a speed-time graph.

(b) The majority of candidates answered this correctly. The most common error was to give an incorrect or insufficient direction, e.g. forward.

Question 2

(a) The vast majority of candidates gained full credit for an answer of 7.7 g / cm^3. The most common error was to give an incorrect or no unit. Another common error was to recall an incorrect rearrangement of the equation for density.

(b) Candidates found this item challenging. Many candidates did not identify the correct name i.e. air resistance or drag, for the upward force. The most common errors were to call the force upward force or even gravity. Some candidates did not realise that at constant speed the upward force was equal in magnitude to the downward force or weight.

(c) Weaker candidates struggled to recall and apply the principle of moments to the balanced beam. The most common error was to try to use some form of W = mg to find the weight of the block. Stronger candidates correctly evaluated the moments equation to give an answer of 2.3 (N).

Question 3

(a) The simple kinetic particle model of matter was well understood by most candidates, and they usually scored full credit.

(b) Candidates were usually able to apply their knowledge of the simple kinetic particle model of matter to the particles in a solid.

(c) (i) Candidates found this item challenging. Many candidates did not identify the correct name for the process of thermal energy transfer through the metal pan as conduction. Common errors included simply stating heat energy, heating or radiation.

(ii) Many candidates did not give a clear description of convection in the water in the pan.

(iii) The majority of candidates answered this correctly. The most common error was to give an incorrect value in kelvin.

Question 4

(a) (i) Not all candidates read the height of the wave as 15 (cm) from the displacement-time graph. The most common error was 30 cm but many candidates gave 5 as their answer, possibly the number of peaks and troughs on the diagram.

(ii) Only stronger candidates could use their understanding of frequency to determine the number of complete waves sent out in one second as 0.5 from the displacement-time graph.

(b) Only stronger candidates gained credit here by identifying diffraction.

(c) (i) Only stronger candidates gained credit here by identifying refraction.

(ii) Despite the wording of the question, many candidates gave an answer of ‘direction changes’.

Question 5

(a) The majority of candidates gained full credit for correctly identifying microwaves and X-rays as the missing regions of the electromagnetic spectrum. Weaker candidates could either not recall the names of the regions or simply repeated some of the regions already on the chart,

(b) The majority of candidates gained at least partial credit here. A common error was to confuse the uses of infrared and ultraviolet radiation. Weaker candidates gave uses such as ‘medicine’ that were too vague for credit.

(c) The majority of candidates scored at least partial credit. A common error was to confuse the harmful effects of infrared and ultraviolet radiation.

Question 6

(a) The majority of candidates stated that the wind turned the turbine, the turbine turned the generator and this generated electricity to score partial credit. Only stronger candidates identified the KE of the wind as the source of energy for the turbine. Weaker candidates believed that the generation of electricity always involves the heating of water to form steam which drives a turbine and consequently, a generator.

(b) The majority of candidates were able to correctly recall the equation power = $V \times I$ and then to rearrange and evaluate the output voltage as 1200 (V). The most common error was to either multiply power and current or to divide the current by the power to give an answer of 0.83.

(c) Only stronger candidates were able to give two advantages of transmitting electrical power at high voltages.

Question 7

(a) Many candidates were unable to identify the distance from the centre of a lens to one of its principal foci as being the focal length of the lens.

(b) A number of candidates were unable to identify the distance from the principal axis to the point where rays from an object converge to as being the image of the object formed by the lens.

(c) Only stronger candidates gave three correct characteristics of the image formed by the converging lens. Generally, ray diagrams for thin lenses were not well understood by candidates.

Question 8

(a) Only stronger candidates answered this correctly. Many other candidates thought the question was about electromagnetic induction and so gained no credit. Stronger candidates gave a clear description of a sensible method for plotting the shape and direction of the magnetic field, giving sufficient detail for someone to be able to follow.

(b) Many candidates showed little understanding of electromagnetic induction and gained no credit here. Some gained partial credit for 'magnetic field produced by coil P' but did not link this to an induced current in coil Q.

Question 9

(a) (i) Only stronger candidates were able to describe the use of the variable resistor to change/control the current in the circuit/heater or to change/control p.d. across the heater. The most common error was to simply paraphrase the question and state that a variable resistor is used to change resistance.

(ii) The majority of candidates gained credit here by determining the number of cells required as 4. The most common error was to multiply the battery voltage and cell e.m.f. to give an answer of 9.

(iii) Only stronger candidates answered this correctly and many candidates did not give an answer.

(b) Many candidates did not recall that the energy, E, transferred by an electric current is calculated using $E = I \times t \times V$. The most common errors were to find the product of I and t or V and t or to have $(I \times V) / t$.

Question 10

(a) (i) Very few candidates answered this correctly. The most common error was to give the nucleon number as 136.

(ii) Many candidates answered correctly but others thought that the number of electrons was the difference between the nucleon number and the proton number.

(b) The most common error was in calculating the mass remaining after two half-lives. Many candidates thought that after 2 half-lives the mass remaining should be zero.

Question 11

(a) Many candidates gained partial credit but others could not identify the Moon and inner planets of our solar system.

(b) Many candidates gained partial credit for this question but others showed that they did not have a secure understanding of this section of the syllabus.

(c) Very few candidates could recall that the diameter of the Milky Way galaxy was of the order of 100 000 light-years.

PHYSICS

Paper 0625/32
Theory (Core)

Key messages

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

In calculations, candidates should set out and explain their working clearly. Credit may be given for correct working even if the final answer is incorrect.

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

General comments

Some areas of the syllabus were better known than others. Interpreting motion graphs, the conservation of energy, transfer of thermal energy, the formation of an image by a converging lens, magnetism, and the magnetic effect of a current and radioactivity 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. Many candidates found the non-numerical questions more of a challenge than the numerical questions. A noticeable number of candidates struggled to express themselves adequately when answering the extended writing questions.

Comments on specific questions

Question 1

(a) (i) This was answered very well, with most candidates most scoring full credit. There was some confusion between a speed-time graph and a distance-time graph. This confusion resulted in a number of candidates determining the gradient of the line to find the speed.

(ii) Most candidates gave the correct answer.

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

(ii) Many correct answers were seen; Candidates correctly linked the gradient of the graph to acceleration. Other candidates made observations that related to a distance-time graph rather than a speed-time graph.

(c) Many candidates recognised that the distance travelled was equal to the area under the graph and applied this knowledge successfully. A common error was omitting the ½ when calculating the area of the triangle.

Question 2

(a) Candidates generally lacked the knowledge for this question. There were a considerable number of no responses.

(b) (i) Most candidates gained full credit here.

(ii) Many candidates were successful here. Answers needed to relate to the information given in the question.

Question 3

(a) The vast majority of candidates gave the correct answer, writing the equation and showing full working.

(b) (i) Stronger candidates were able to apply the principle of moments correctly. Other candidates gained credit for calculating the moment of the spring about the pivot. Common errors were attempts to apply *mgh, mg* or *Fd* to the situation.

(ii) Many candidates did not recognise that the information required was on the graph (**Fig. 3.3**). Others correctly found the extension from the graph. The extension needed to be added to the original length to obtain full credit.

Question 4

(a) The vast majority of candidates gave the correct answer, writing the equation and showing full working.

(b) (i) This was a 'show that' question. Answers needed to show each step in the calculation to achieve full credit. For such questions this will usually include writing the equation, substituting the correct values into the equation, and then working out the answer.

(ii) Candidates needed to understand that mechanical work done is equal to the energy transferred. The work done on the books was equal to the gain in gravitational potential energy in this case. A number of candidates did not offer an answer.

Question 5

(a) A number of candidates gave advantages that were too vague, e.g. "a clean source of energy", "environmentally friendly", "less contamination". More detailed, specific answers such as "no greenhouse gases emitted" or "does not contribute to acid rain" were required. Also, just "no pollution" was insufficient, whereas "no air pollution" would have gained credit.

(b) Significantly more candidates gave disadvantages that were either too vague, economic or irrelevant, e.g." unreliable", "expensive to build or repair" or "takes up a lot of land". More detailed specific answers such as "limited production time", "difficult to maintain" or "disrupts shipping" were required.

Question 6

(a) Few correct answers were seen. Candidates needed to recognise that a medium is needed for thermal energy transfer by conduction and convection but not radiation.

(b) 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 recognising that the demonstration related to convection and/or that the heated water would rise.

Question 7

(a) Some confusion between the motion of the particles in a longitudinal wave and a transverse wave was seen. A number of candidates did not give an answer.

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

(ii) The vast majority of candidates achieved full credit by writing the equation and showing full working.

(c) A large number of candidates gained partial credit for knowing the correct unit but recall of the range was less secure. A number of candidates did not give an answer.

Question 8

(a) Most candidates recognised refraction but fewer recognised diffraction. A common error was drawing two lines from each illustration.

(b) (i) Few correct answers were seen here. A significant number of candidates thought that the line was a normal or gave no response.

(ii) Candidates who read the question carefully realised the name of a point was required and gained credit. Other candidates incorrectly gave the answer focal length.

(iii) A common misconception was just to identify the point where the rays cross with the label 'image'. The correct response was a vertical arrow from this point to the principal axis. In this case, the arrow should have been inverted. A number of candidates did not give an answer.

(iv) Few candidates recognised that the focal length was the distance between the centre of the lens and point F.

(v) Most candidates achieved some credit here. The most common error was confusion between virtual and real images. Answers identifying contradictory characteristics e.g. inverted and upright scored zero marks for this question.

Question 9

(a) (i) Many correct answers were seen. Other answers were too vague e.g. "the heater is still on" or "the current is still flowing" without making the safety link to the risk of someone getting an electric shock.

(ii) Candidates who recalled that *power = current x potential difference* usually obtained full credit. Other candidates made incorrect attempts using the *potential difference = current x resistance* equation.

(b) The majority of candidates gave the correct answer. A common error was to add the meter readings rather than subtracting them. This could still gain some credit if the incorrect number of kWh was then multiplied by the cost per kWh.

Question 10

(a) (i)(ii) Some confusion between the magnetic properties of iron and steel was evident.

(ii) Answers tended to be too vague or incomplete, e.g. "place the non-magnetic material near the magnet".

(b) Few candidates were able to give a full detailed explanation. A common answer, scoring partial credit, included an understanding that there would be a current flowing which would have a magnetic effect.

Question 11

(a) (i) Candidates generally lacked knowledge of nuclide notation or confused the atomic number and mass number.

(ii) Many correct answers were seen.

(b) (i) This question asking for diagrams: plural. Almost all candidates only gave one response so could not gain credit.

(ii) Few candidates recognised that atoms form positive ions by losing electrons.

(c) Often candidates incorrectly divided the two count rates. A number of candidates gained at least partial credit for recognising that time period was equivalent to 3 half-lives. A noticeable number of candidates achieved full credit.

Question 12

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

(b) Most candidates were able to name one natural object that orbits the Sun, with asteroids and moons being the most common. A significant number of candidates correctly named two objects.

(c) This question was answered well by candidates.

PHYSICS

Paper 0625/33
Theory (Core)

Key messages

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

In calculations, candidates should set out and explain their working clearly. Credit may be given for correct working even if the final answer is incorrect.

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.

General comments

Some areas of the syllabus were better known than others. In particular, transfer of thermal energy, the electromagnetic spectrum, high-voltage transmission of electricity, magnetism and the magnetic effect of a current and radioactivity were not well understood. Equations were generally well known by all but the weakest candidates. Many candidates understood how to apply equations to fairly standard situations well. For many candidates, the non-numerical questions were more of a challenge than the numerical questions. A noticeable number of candidates struggled to express themselves adequately when answering the extended writing questions.

Comments on specific questions

Question 1

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

(b) This was answered well with many candidates gaining full credit. Some confusion between a speed-time graph and a distance-time graph was evident.

(c) Many candidates recognised that the distance travelled was equal to the area under the graph and also applied this knowledge successfully. A common error was omitting the ½ when calculating the area of the triangle.

(d) Most candidates gained full credit here.

Question 2

(a) (i) Many candidates were successful here. Answers needed to relate to the information given in the question which stated that the barrel was moving at constant speed.

(ii) This was a 'show that' question. Answers needed to show each step in the calculation to achieve full credit. For such questions this will usually include writing the equation, and then substituting the correct values into the equation or working out and writing the exact answer.

(b) (i) The vast majority of candidates gave the correct answer, writing the equation and showing full working.

(ii) A number of candidates gave environmental reasons that were too vague, e.g. “a clean source of energy”, “environmentally friendly”, “less contamination” etc. More detailed specific answers such as “no greenhouse gases emitted” or “does not contribute to acid rain” were required. Also, just “no pollution” was insufficient, whereas “no air pollution” would have gained credit.

Question 3

(a) Most candidates attempted this question with many getting the correct answer. A common error was to divide the mass by $9.8\,m/s^2$ instead of multiplying by $9.8\,m/s^2$.

(b) Many candidates answered this question well by writing the equation and showing full working. Others either rearranged the density equation incorrectly or substituted the mass in kilograms rather than grams.

(c) Candidates who positioned their letters carefully on the diagram scored full credit.

Question 4

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

(ii) Very few candidates recognised that a shiny surface is a poor emitter of radiation.

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

(b) Candidates needed a fuller understanding of how density changes explain the formation of convection currents in air. A number of candidates gained partial credit for recognising that a convection current would be formed and/or that the heated air would rise.

Question 5

(a) (i) Many candidates answered this question well. Common incorrect answers were Y-rays, sound waves and alpha waves.

(ii) Candidates generally lacked sufficient knowledge about electromagnetic waves to answer this question. A number of candidates did not give an answer.

(b) (i) A large number of candidates gave disadvantages that were too vague, e.g. heating or security. More detailed specific answers such as electric grills, treatment of damaged muscles or intruder alarms were required.

(ii) Candidates tended to give the harmful effects of other regions of the electromagnetic spectrum rather than the specific effects relating to infrared radiation.

Question 6

(a) (i) A number of candidates did not give an answer. However. almost all candidates who answered were correct.

(ii) The vast majority of candidates achieved full credit.

(b) Many correct answers were seen. A common error was rays being refracted correctly inside the lens but emerging parallel.

(c) A considerable number of candidates correctly named all seven colours but the knowledge that violet has the highest frequency was less secure. Weaker candidates included white as one of the colours.

Question 7

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

(b) This was a 'show that' question. Answers needed to show each step in the calculation to achieve full credit. For such questions this will usually include writing the equation, substituting the correct values into the equation and then working out and writing the exact answer.

(c) Candidates generally lacked knowledge that resistors of equal value connected in series would share the supply voltage equally.

(d) Candidates who recalled that *power = current x potential difference* usually obtained full credit. Other candidates made incorrect attempts using the *potential difference = current x resistance* equation. A number of candidates did not give an answer.

(e) Many candidates recognised that the combined resistance of two resistors in parallel is less than that of either resistor by itself. A number of candidates did not give an answer.

Question 8

(a) A significant number of candidates answered this question well. Other candidates were able to recall the correct equation and gained partial credit. A number of candidates did not give an answer.

(b) Candidates generally lacked the knowledge of high-voltage transmission that was required for this question. Answers were generally vague and a number of candidates did not give an answer.

Question 9

(a) Candidates generally lacked an understanding of alternating current.

(b) (i) Few candidates were able to give a full detailed explanation. A common answer that gained partial credit was an understanding that the current flowing would have a magnetic effect.

(ii) A large number of candidates gained partial credit for knowing the correct unit. A number of candidates did not give an answer.

Question 10

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

(ii) Many correct answers were seen. Some confusion between atomic and mass numbers was evident.

(ii) Few candidates understood that atoms form positive ions by losing electrons.

(b) A number of candidates gained at least partial credit for recognising that time period was equivalent to 3 half-lives. A noticeable number of candidates achieved full marks.

Question 11

(a) (i)-(iii) The majority of candidates gave correct answers to these three parts.

(iv) Most candidates were able to name one of the gases. A significant number correctly named two objects.

(b) (i) Many correct answers were seen. A number of candidates did not give an answer.

(ii) A large number of candidates gained at least partial credit for the equation *speed = distance/time.* Many were also able to rearrange the equation and obtain the correct answer. In almost every case, incorrect answers had no working, so no credit could be given.

PHYSICS

Paper 0625/41
Theory (Extended)

Key messages

Candidates should ensure they read questions carefully and that they answer the question being asked exactly. The number of marks allocated to a question gives an indication of the detail required in an answer.

Stating any formulae used before performing a calculation helps ensure that partial credit is available if, due to some arithmetic error, the final answer is incorrect. Final answer marks for calculations are only awarded for correct numerical answers with the correct unit. Where either the numerical value is incorrect or the unit is missing or incorrect, marks will only be awarded for working shown by candidates.

When asked to 'show that' a quantity has a particular value, candidates must demonstrate that they know the formula they are applying. They should be advised to write down the formula in words or symbols. Manipulation of numbers given in the question to achieve the correct numerical answer is insufficient to demonstrate understanding of the physics in the situation. This applied in **Question 1(b)(ii)** and **Question 3(b)(i)**.

General comments

Many candidates had prepared well for this examination demonstrating a good understanding across a range of topics within the physics syllabus. The one exception to this was **Question 10** where a number of candidates made no attempt at multiple parts of this question suggesting a lack of familiarity with this new area of the syllabus.

Candidates generally demonstrated a good understanding of quantitative skills with questions involving calculations. However, some weakness in working with numbers in standard form was apparent in **Question 10(c)(i)** and **Question 10(c)(ii)**.

Candidates are expected to give numerical answers to two significant figures unless instructed otherwise and almost all candidates did this throughout the paper. Candidates must also include the correct unit with any numerical final answer. In **Question 1(a)** and **Question 1(b)(i)** the unit was sometimes missing and in **Question 8(a)** and **Question 10(c)(i)** the unit was often missing.

When writing down formulae candidates are expected to use the symbols for physical quantities given in the syllabus. Any alternative symbol will only gain credit if it is clearly (and correctly) defined. This applied particularly in **Question 1(b)(ii)** and **Question 3(b)(i)** where candidates were asked to show that a quantity had a given value.

When candidates wish to alter their answer, they should cross out the response they do not wish to be considered and write their new answer down clearly (if necessary, using spare blank space in the answer booklet or a continuation sheet and identifying the question number they are answering).

Comments on specific questions

Question 1

(a) Stronger candidate correctly recalled the formula for gravitational potential energy, substituted numerical values and gave the answer with the correct unit. Some weaker candidates omitted g (acceleration of free fall) from their equation while others gave an incorrect unit or omitted the unit from their answer.

(b) (i) Most candidates remembered the formula for kinetic energy correctly. When substituting values into the equation, a significant number of candidates did not square the velocity and others calculated the difference in the velocities before substituting. Weaker candidates either omitted the unit, gave an incorrect unit or were unable to recall the correct formula.

(ii) Candidates who understood that velocity, and therefore change in momentum, is a vector quantity gained full credit. They needed to write down the equation they were using and to show the correct change of momentum by identifying one of the velocities as negative with respect to the other (positive) velocity. Some candidates took short cuts and did not show that the velocities were in different directions. Most candidates obtained partial credit for correctly calculating the modulus of the momentum before and after the ball bounced. Some weaker candidates realised that the required answer was the sum of the modulus of the momentum values and rewrote the formula for change in momentum to fit. A few weaker candidates subtracted their KE in **(i)** from their GPE in **(a)**.

(iii) The strongest candidates recognised that change in momentum = force × time, used the value for change in momentum given in **(ii)** and so calculated the correct answer. Most candidates attempted to answer this question by using F =ma and a = $\Delta v / \Delta t$. A common error with this method was to recalculate the change in velocity without accounting for the change in direction and so to give an answer of 1.6 N. Partial credit was awarded with both formulae in this method, but no credit was given for just the equation F = ma.

Question 2

(a) Most candidates understood that copper contains delocalised electrons, but only stronger candidates were able to describe their role in conduction. Stronger answer to this question included a reference to the electrons gaining energy from particles, moving through the metal and transferring the energy to distant particles. Some candidates wrote about transfer of energy via particle vibrations suggesting that either they had not read the question carefully or that they misunderstood what lattice vibrations are. A few weaker candidates attempted descriptions of radiation or convection rather than another way that thermal energy is conducted.

(b) In this question, candidates were asked to select the particular property of shiny surfaces relevant when using a pan to heat food. They needed to recognise that avoiding the loss of thermal energy was the desired advantage and the relevant property of a shiny metal was that they are poor emitters of radiation. A reference to shiny surfaces being poor emitters, without mentioning radiation (or equivalent) did not gain credit. Many candidates mentioned shiny surfaces being poor absorbers of radiation or good reflectors of radiation, which was not relevant to this question.

(c) Many candidates correctly identified convection as the main method of thermal energy transfer through water.

Question 3

(a) Most candidates were able to state that the particles in liquids are close together or the equivalent. A completely correct answer required the additional statement that repulsive forces between particles in liquids are large. Some candidates wrote down general statements about the properties of particles in a liquid, such as that particles slide over each other, without applying the statement to the question asked.

(b) (i) Showing that the pressure due to the water at the base of the block is approximately 850 Pa required more than manipulating the numbers given in the question to calculate 852. Most candidates were able to recall the formula for calculating the pressure in a liquid before substituting the values correctly to gain full credit. Candidates using symbols other than those given in the syllabus should define them clearly. A few candidates worked from first principles, using the equations p = F / A and **ρ** = m / V with varying degrees of success.

(ii) This was answered well with most candidates able to recall the equation p = F / A, and many able to rearrange it correctly and give the correct unit.

(iii) There were many good answers here with candidates correctly applying the equation m = W / g. Weaker candidates recalled the equation incorrectly or were confused about whether they were finding the mass or weight. Some candidates calculated the value correctly but then gave the unit as g instead of kg.

Question 4

(a) (i) Few candidates gave a precise enough answer to this question. Many referred to gravity rather than weight or the force of gravity. Weaker candidates referred to the centre of gravity as being the point where most of the weight acts or the point at which the object balances. Although correct statements about the centre of mass were credited, it should be noted that the syllabus now requires understanding of the centre of gravity as distinct from centre of mass.

(ii) Only stronger candidates gave the expected answer relating the idea that a small tilt or rotation makes G no longer vertically above the base or that a small tilt or rotation produces a moment. Some candidates gained credit by stating that both the centre of gravity was high and the base area was small. Weaker answers only referred to either the position of the centre of gravity or the area of the base. The weakest candidates were unable to answer the question and just tried to explain the role of the wires in holding up the transmitter or described some detrimental effect on the transmission of radio waves.

(b) (i) Few candidates correctly identified T as pointing in the direction of the wire and towards the ground. Many candidates showed T pointing towards the point of contact between the supporting wire and the transmitter and at right angles to the transmitter or along the wire and away from the ground.

(ii) Many candidates correctly stated that moment = force × perpendicular distance from pivot. Some omitted the word perpendicular, and others said it was the distance to the centre of gravity or another location other than the pivot. Very few managed to draw the correct perpendicular distance, either not attempting to draw it or expecting the force to be perpendicular to the transmitter.

(c) There were many correct answers with the most common being the use of (mobile) phones, Some candidates gave answers that were too vague, e.g. “communication” and others confused radio waves with sound waves and referred to sonar. Weaker candidates often just repeated the example given in the question.

Question 5

(a) Candidates were able to gain full credit here for a description of hydroelectric, tidal or wave energy being used to generate electricity. Most candidates recognised that the energy in water is used to turn a turbine. Some candidates confused tidal and wave energy giving an answer that was a mixture of the two methods of electricity generation. Weaker candidates sometimes described electricity generation from energy stored in fuels which heat water rather than energy stored in the water being the source.

(b) Candidates needed to be specific in answering this question. Low running costs are an advantage of hydroelectric power and high building costs are a disadvantage. A vague reference to cost did not gain credit as either an advantage or disadvantage. The most common advantage given was that it is renewable. Common disadvantages related to the availability of water or suitable locations for a power plant or the high cost of building dams.

(c) Many candidates gained full credit here. Others recalled one method for which the main source of energy is not the Sun.

Question 6

(a) (i) Most candidates were able to locate the image. Most often a ray was drawn from the top of the object, through the centre of the lens and then a second ray from the top of the object, parallel to the principal axis to the lens and then refracted through F. These rays were then extrapolated back to locate the top of the image at their intersection. Some candidates refracted rays at the lens to some random point along the principal axis (instead of F), while others bent their extrapolated rays (sometimes to force the image to be at F). The weakest candidates were not able to construct two correct rays and either formed a real image or did not manage to form an image at all.

(ii) Candidates scored partial credit for an accurate image with careful drawing of rays using a ruler, sharp pencil and refracting rays at the centre of the lens. To gain full credit, candidates needed to convert the scaled distance from **Fig. 6.1** to the actual distance from the lens. Few candidates managed to do this. Often rays were drawn with insufficient care to get an accurately positioned image. Weaker candidates were confused by the scale diagram and often scaled up the actual distance from the lens.

(b) Most candidates who identified a virtual image also provided a suitable explanation. The most common explanation was that it cannot be projected on a screen. Weaker candidates were unable to explain why it was virtual or they thought it was a real image.

(c) Stronger candidates stated that a converging lens would reduce the (overall) focal length of the eye and cause rays to intersect (or a focussed image) on the retina, rather than behind it. A significant number of candidates referred to magnification of the object rather than a focussed image. Some referred to rays reaching the retina rather than meeting there. Weaker candidates did not correctly interpret long-sightedness as meaning that distant objects are in focus but closer ones are not.

Question 7

(a) Most candidates stated that electrons (or negative charges) moved from the cloth to the rod, gaining full credit. Some candidates incorrectly suggested that the cloth had a net negative charge at the start. Weaker candidates incorrectly stated that positive charges move.

(b) (i) Only the strongest candidates clearly expressed that an electric field is a region where a charged particle experiences a force. A common insufficient answer was to describe it as an area around a charged particle where a force is felt, without stating that it is a charged particle that experiences the force.

(ii) Stronger answers had straight, radial lines, drawn with a ruler, evenly spaced around the sphere, touching the sphere (but not extending inside) and with arrows pointing inwards. Common errors included very unevenly spaced lines or lines which did not reach the sphere. Weaker candidates drew curved lines or circles around the sphere and a few candidates had arrows pointing away from the centre of the sphere.

(c) Only stronger candidates drew an arrow along a radial line from the centre of the sphere, through Z and pointing away from the sphere. The two most common errors were to draw an arrow pointing towards the centre of the sphere or to draw the force as a horizontal line from Z.

Question 8

(a) (i) Most candidates recalled the equation Q = It, correctly substituted the numbers and correctly gave the unit as Coulombs. Some candidates gave an incorrect unit or omitted the unit in their answer. Candidates who did not calculate the correct value could still gain some credit for writing the formula in words or symbols. However, an equation written with units (instead of words or symbols) was not given credit. Weaker candidates tried to use an incorrect equation, such as $E=Vit$.

(ii) Most candidates realised that they needed to use the equation V = IR and so gained at least partial credit. Many of them correctly calculated that the total resistance of the circuit was 6.0 Ω. Candidates who scored full credit realised that the resistance of P had to be subtracted from this total resistance to get the resistance of the clay cylinder.

(b) Many candidates were able to apply their knowledge of the relationship between resistance and length, and resistance and area, to calculate the resistance of the new cylinder of clay as 4 times the value calculated in **(a)(ii)**. Only the strongest candidates realised that this was not the resistance of the complete circuit and others were unable to calculate the new value of current to use with Q = It to find the time for the charge to flow through the circuit. Many weaker candidates made no attempt at this question.

Question 9

(a) (i) Many candidates misjudged the specificity of this question. They were asked to state how the composition of a nucleus of americium-241 differs from the composition of a nucleus of americium-242. Stating that it contains a different number of neutrons was insufficient to gain credit. This question required the clear statement that americium has one less neutron in its nucleus (or americium-242 has one more neutron).

(ii) Stronger candidates recognised that both the number of protons and the number of neutrons would be different. Candidates who stated, for example, that there will be more protons, were given full credit only if they stated that there will be fewer neutrons. Weaker candidates often mentioned changes to the number of electrons or tried to suggest different properties of the elements and therefore did not answer the question.

(b) (i) Most candidates were able to complete the nuclide equation for the decay of americium-241 with emission of an alpha particle correctly and gained full credit.

(ii) Many candidates recognised that being less penetrative, slower or more massive contributed to greater ionisation and these were all creditworthy ways of expressing the syllabus statement linking greater ionisation to greater kinetic energy. Few candidates made a clear statement that alpha particles have a greater magnitude of charge than beta particles.

(iii) Candidates needed to read the information given carefully. The neptunium with the long half-life is a waste product which, when it decays, will produce a more harmful radiation. Therefore, the advantage of this long half-life is that there will be very few emissions per unit time or a low initial activity and this means an old smoke detector is less of a hazard either to human health or for safe disposal. Most candidates misread the question and thought the long half-life would mean the smoke detector lasts a long time. Weaker candidates were also likely to incorrectly state that a long half-life meant that the neptunium would not emit radiation for a long time or that the long half-life meant that there will be few emissions, without making any reference to a time period.

Question 10

(a) Stronger candidates described how hydrogen nuclei fuse to produce helium nuclei in the core of a stable star. Candidates gained credit for mentioning that nuclear fusion occurs. However, spelling of this technical term was critical to be sure that candidates did not mean fission. Therefore, fussion was not an acceptable spelling. Weaker candidates often described atoms fusing instead of nuclei. Some candidates misread the question and described the evolution of a star through its different stages which did not answer the question.

(b) (i) Many candidates were able to gain credit here recognising that the observed light has an increased wavelength. Those that did not give the precise difference often gained partial credit for recognising that the light was shifted towards the red end of the spectrum. A common error was to describe the difference in terms of brightness of the light.

(ii) Only the strongest candidates stated that the quantity used to determine the speed at which the galaxy is receding is the change in wavelength and this was most often expressed as the redshift. A variety of incorrect responses included, light year, Hubble constant and 3×10^8 m / s.

(c) (i) Many candidates gained full credit here, recalling the equation $H_0 = v / d$ and rearranging and substituting the values to give the correct distance. A common error was to omit the unit in the answer. Some candidates made errors in handling indices leading to a power of ten error in the final answer. Most candidates attempted this question, even those who omitted all the other parts of **Question 10**.

(ii) The strongest candidates used the formula approximate age of universe = $1 / H_0$ and converted their answer in seconds into years to gain full credit. A few candidates also gained full credit with a correct answer with no working shown, suggesting recall of a learned fact. Weaker candidates often gave the answer in seconds without conversion to years.

PHYSICS

Paper 0625/42
Theory (Extended)

Key messages

Candidates should be advised to:

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

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

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

General comments

Many candidates showed that they had a wide knowledge and understanding across the syllabus. The space physics part of the syllabus was much less well known, especially the life cycle of a star which was examined in **Question 10**. A significant number of candidates did not attempt parts of this question and there were many incorrect answers.

When asked to 'show that' a quantity has a particular value, candidates must demonstrate that they know the formula they are applying. They should be advised to write down the formula in words or symbols. Manipulation of the numbers given in the question to achieve the correct numerical answer is insufficient as it does not demonstrate understanding of the physics of the situation. This was relevant in **Questions 1(c)** and **6(c)**.

Candidates are expected to use symbols for physical quantities given in the syllabus. Any alternative symbol will only gain credit if it is clearly and correctly defined. This particularly applied in **Question 3(a)(i)** where credit was not given for the use of the symbol *s* instead of *v*. In **Question 4(b)** *Q* was not an acceptable alternative for *E*.

Careful drawing of straight lines, using a ruler and a sharp pencil was required in **Questions 1(b)(i)**, **3(b)**, **5(a)**, **5(b)** and **5(c)**.

Comments on specific questions

Question 1

(a) (i) This question was answered correctly by most candidates. Stronger candidates gave the correct answer to two significant figures with the correct unit. Some weaker candidates were unable to state the correct equation for acceleration, gave the answer to only 1 significant figure or gave the incorrect unit.

(ii) Fewer candidates were able to answer this question accurately. Stronger candidates explained that acceleration is the rate of change of velocity. Weaker candidates stated the equation for acceleration or stated that acceleration is the rate of change of velocity over time or per s. Candidates needed to be precise in giving their explanations.

(b) (i) The speed–time graph was accurately drawn by most candidates. Stronger candidates read the scale carefully and used a sharp pencil and a ruler to draw straight lines.

(ii) Most candidates realised that they needed to calculate an area under the graph. The area required was the area of a triangle. Some candidates calculated the area under the entire graph. Weaker candidates calculated the gradient of the straight line or used the equation $d = vt$ with the maximum velocity being used for v instead of the average velocity.

(c) Stronger answers to this 'show that question' were those where candidates wrote down both equations required to calculate the work done, substituted values correctly, including a calculated value for acceleration, and did not make any internal rounding of numerical values. The equations required were $W = Fs$ and $F = m(v-u) / t$. Weaker candidates omitted the equations in symbols or used g as the value for acceleration. An alternative acceptable method was to equate the work done with the change in kinetic energy. For full credit using this method, candidates needed to state that the work done = change in kinetic energy.

(d) Stronger candidates gave a clear reason for the increase in stopping distance, e.g., the brakes were worn and that this resulted in the decelerating force being reduced. Non-creditworthy answers included those which were too vague, e.g., "friction was less" and some candidates misunderstood or misread the question, referring to different speeds as part of their explanation.

Question 2

(a) (i) Many candidates were able to identify that the process by which the water was removed by the clothes was evaporation. Common incorrect answers were condensation or convection.

(ii) Stronger candidates gave a clear statement that the air would be drier or contain less water vapour or moisture when leaving the condenser and that the reason for this was that the water vapour had been condensed or turned back to liquid in the condenser. Many candidates referred to air entering the condenser instead of leaving it. Candidates were given credit for stating that the air leaving the condenser would have increased density. Incomplete explanations included statements that the density increased due to a decrease in the kinetic energy of the air instead of the kinetic energy of the air particles decreasing. The weakest candidates repeated the statement in the question about cool air leaving the condenser. A number of candidates made no attempt or only a partial attempt at answering this question.

(b) (i) The question asked for the name of a force and the answer required was gravitational (force) or weight. Many candidates gave insufficient statements, e.g. gravity. Gravity alone was not acceptable as the name of a force.

(ii) Stronger candidates gave a clear statement about direction of the force in circular motion being perpendicular to the motion. An answer of perpendicular to the drum or to/from the centre of the drum was also acceptable. An answer of centripetal force did not answer the question.

(c) This question asked for a suggestion of why drying clothes in the open air is better for the environment. Stronger candidate explained that the tumble dryer used electricity which could have been produced from fossil fuels or that drying clothes on a clothesline used renewable energy. Weaker candidates simply stated that electricity was not needed or that it was cheaper. Some candidates suggested that the hot air released by the tumble dryer contributed to global warming or that the tumble dryer produced greenhouse gases. The weakest candidates did not answer the question as they referred to the process of evaporation for drying clothes on a clothesline.

Question 3

(a) (i) A large number of candidates gave the correct answer of force × time or change of momentum. Common incorrect answers included the rate of change of momentum, the use of symbols when the question specifically asked for words or force per time, etc.

(ii) Stronger candidates identified that they needed to calculate the change in momentum to find the impulse, showed their working to find Δ v and then gave the correct unit. Unless candidates gave the unit as g m/s they needed to convert g to kg. Some candidates stated that they were calculating speed, and this was unacceptable as momentum is a vector. Others confused force with impulse or calculated a value of 3.72 as acceleration.

(iii) Candidates needed to refer to the momentum and direction of movement of both the balloon and the air released from it. Many candidates just stated the law of conversation of momentum and most only referred to the balloon. Very few identified that the air released from the balloon travelled in the opposite direction to the balloon. A few identified that the momentum of the balloon was equal in size to the momentum of the air.

(b) Most candidates gaining credit chose to draw an accurate vector diagram and then measured the correct angle and the correct length, giving their answers in N and °. The alternative method was to use Pythagoras to find the force and trigonometry to find the angle. The most common error was to draw an incorrect vector diagram. Many candidates just copied the diagram in the question, sometimes to scale, and joined the two ends. Other errors included finding the angle with the vertical instead of the horizontal or omitting the unit from one or both quantities.

Question 4

(a) (i) Most candidates showed understanding of the kinetic particle model of matter and made a good attempt at this question. Nearly all candidates could identify that the particles had greater kinetic energy, or speed, and many could also explain that the force of collisions of particles increased or that there were more frequent collisions, etc. Three different statements explaining why the pressure increased were needed for full credit. Weaker candidates did not give comparative detail, and only explained why particles produced a force, not why it was a greater force or stated there would be more collisions instead of more frequent collisions.

(ii) Many candidates referred to air particles escaping from the bottle. Few candidates stated that the pressures inside and outside the bottle would become equal. Some candidates confused water particles with air particles or described evaporation from the water.

(b) This question was answered well with many candidates giving the correct answer with the correct unit. Most candidates were able to recall and use the equation $c = \Delta E / m\Delta\Theta$. Unless symbols used are clearly defined only symbols in the syllabus should be used. In this question no credit was given for the use of *Q* in place of *E* or *t* in place of Θ or *T.* Common errors were the use of the wrong unit, incorrectly rearranging the equation, or omitting *m* or $\Delta\Theta$.

(c) Most candidates gained at least partial credit for this question. Those who converted the height of the liquid from cm to m usually gained full credit. Some candidates gave an incorrect unit or omitted the unit.

Question 5

(a) Stronger candidate drew a straight line from X which just touched the high wall to the left of the truck, drew a point on this line and labelled the point Y. Many candidates did not mark an actual point but just wrote a letter Y. Many candidates were unable to demonstrate that they understood that light travels in straight lines and cannot pass through walls.

(b) Stronger candidates drew accurate straight lines from a point on the car to the mirror and from the mirror to the driver with an angle of incidence equal to the angle of reflection. Many candidates realised that the angle of incidence is equal to the angle of reflection but did not draw that accurately. Weaker candidates drew lines not starting from the car or not travelling towards X and some drew multiple reflections from the wall.

(c) Most candidates understood that the light rays would be brought to a focus on the retina, and many gave a completely correct answer with an additional converging lens between the object and the eye lens, rays refracted at both the additional lens and the eye lens, and rays meeting on the retina. Common errors included the use of a diverging lens, additional refraction between the object and the additional lens or within the eye and no refraction at the eye lens.

Question 6

(a) Most candidates realised that they needed to use the equation $V = IR$ and gained at least partial credit. Full credit was obtained by those candidates who subtracted the value they obtained from the e.m.f. of the battery to obtain the p.d. across the LED. Many just gave the answer for the p.d. across the resistor.

(b) Stronger candidates stated that the LED was a diode which would only allow current in one direction. Weaker candidates just stated that the current did not flow.

(c) Stronger candidates wrote down the equation $E = VIt$ for this 'show that' question, substituted values correctly and showed conversion from s to h. If candidates wrote the equation $P = VI$, they also needed to write the equation $P = E / t$. A few candidates did not attempt this question.

(d) Many candidates correctly recalled the equation $Q = It$, correctly substituted the numbers and gave the unit as Coulombs. Weaker candidates were unable to recall the correct equation or omitted this question.

Question 7

(a) Nearly all candidates answered this question correctly, demonstrating that they had good knowledge of the uses of different regions of the electromagnetic spectrum. The most common incorrect answer was to link photography of people's faces with infrared.

(b) The correct numerical answer and a correct unit were needed for credit to be awarded. Common errors were the omission of a unit or a value with an incorrect power of ten or the value given as the speed of sound in air.

(c) (i) Most candidates gained credit for stating the correct formula for wave speed and correctly calculating the mid-point of the frequency range. Candidates then needed to give a correct conversion from GHz to Hz and this was done incorrectly, or not attempted, by many candidates. Some candidates omitted the unit or gave an incorrect unit.

(ii) Stronger candidates stated that radio waves lose energy or that the signal strength decreases when passing through walls. However, few candidates understood this and there were many irrelevant answers about the frequency or wavelength of radio waves.

Question 8

(a) Most answers were correct. Weaker candidates omitted the word 'number' from their answer or confused atomic mass with nucleon number.

(b) (i) This was usually answered correctly. Weaker candidates gave answers of fusion, fision or fussion – care must be taken with spelling of similar terminology. Others gave answers of nuclear energy or radiation.

(ii) Stronger candidates stated that when the uranium split into more stable nuclei, the nuclei had a smaller total mass and that the mass difference was converted to thermal energy. This new part of the syllabus was not understood by most candidates. There were references to the mass remaining the same or increasing or to the mass of uranium decreasing and to energy decreasing. Some candidates did not attempt to answer this question.

(c) (i) There were some strong answers that gave well-ordered sequence of stages in the generation of electricity from thermal energy from nuclear reactions. The process was usually expressed as thermal energy producing steam which turns turbines which drive a generator to produce electricity. Some candidates correctly described the operation of the generator due to turbines moving magnets near a coil. There was some confusion with references to motors instead of generators. Weaker candidates often referred to the use of fossil fuels or wind turbines or just stated that thermal energy was converted to kinetic energy or electrical energy. A few candidates did not attempt to answer this question.

(ii) Stronger answers to this question were specific, for example stating that a large amount of energy was produced by a small amount of fuel for the advantage, and that toxic waste was produced. Many answers were too vague, for example stating that a large amount of energy was produced without reference to a smaller amount of fuel needed or that radioactive or nuclear waste is produced without reference to it being toxic or that it caused storage problems.

Question 9

(a) The information provided in Table 9.1 allowed candidates to deduce that X must be either Venus or Mercury and either answer was given credit. The data given was the data for Venus. The most common incorrect answer was Mars.

(b) Many candidates answered this correctly. References to proportionality were ignored and many candidates then stated that the gravitational field strength increases with mass and credit was given for this.

(c) Stronger candidates stated that the paths of the planets were elliptical or not perfect circles. Common insufficient or incorrect answers were that the distance from Sun varies, that it is too far away to measure and that all planets are different distances from the Sun.

(d) Stronger candidates wrote down the equation for orbital speed in symbols, correctly calculated the time in s and substituted values into the equation correctly. Many candidates gained partial credit for correctly stating the equation or correctly calculating the time. A common error was the omission of 2π. A number of candidates omitted this question.

Question 10

(a) Few candidates stated clearly that protostars are formed from clouds of gas and dust or stellar nebula. A wide range of incorrect responses were given such as rocks, stars, fusion, black holes, red supergiants, etc.

(b) Stronger candidates gave their answers in terms of a balance between inward and outward forces and correctly identified the causes of the forces. The inward gravitational force was better known than the outward force due to high temperature in the centre of the star. A large number of candidates did not attempt this question.

(c) Many candidates correctly stated that hydrogen is the initial fuel used to power nuclear reactions, but a large number of candidates made no attempt at this question. Common incorrect responses included black holes, gamma rays, helium, uranium, supernova.

(d) Few candidates knew that in the life cycle of a star, red giants then form a planetary nebula. A number of candidates did not attempt this question.

PHYSICS

Paper 0625/43
Theory (Extended)

Key messages

Numerical answers should be given to the required number of significant figures, with the correct unit. Final answer marks for calculations are only awarded for correct numerical answers with the correct unit. Where either the numerical value is incorrect or the unit is missing or incorrect, marks will only be awarded for working shown clearly by candidates.

When candidates are asked to write down an equation to define a quantity, the subject of the formula should always be included.

Candidates should take note of the command word and mark allocation of questions and should use these details to ensure they answer appropriately.

Candidates are expected to use the symbols for physical quantities given in the syllabus. If a different symbol is used for a quantity, it should be clearly defined.

General comments

The majority of candidates were well prepared for this paper and were able to demonstrate some ability and understanding across the whole of the range of the content being tested. The areas that were less well answered were the characteristics of the filament lamp and the half-life of the isotopes for different applications. For weaker candidates the questions relating to the Hubble Constant, H_o and CMBR proved more challenging.

Candidates must take care not to write alternative answers on the answer lines. They need to be aware that an incorrect answer can contradict a correct one.

Note should be taken of the command word in each question before answering. In particular, it helps candidates to understand the difference between stating (which means to express in clear terms) and explaining (which means to set out purposes or reasons/make the relationships between things evident/provide why and/or how and support with relevant evidence). Candidates often wrote long explanations for **Questions 7(a)(ii)** and **10b.**

If candidates go back to check a previously answered question and change the answer to one part of a question e.g. **(i)**, they must remember to also check the answers to subsequent question parts which may use the initial value in a calculation. This caused a particular problem to some candidates in **Question 6(b)**.

Comments on specific questions

Question 1

(a) Almost all candidates correctly described the final position of oil as being on top of the water and explained that this is due to the lower density of the oil.

(b) (i) Most candidates understood that water needed to be displaced and the strongest candidates stated that they were using a measuring cylinder rather than a container and measuring the volume rather than the amount of water. However, many answers lacked the required detail using vague phrases such as, “record the measurement” or “find the difference in the level”. There needed to be some explicit reference to volume and not just to the level or amount.

(ii) Many candidates gained full credit here. There were some occasional errors with the units and powers of ten if candidates attempted to convert the volume into m^3 or the density into kg/m^3. It is useful for candidates to know that if the volume is measured in cm^3 and the density in g/cm^3 it is simpler to leave them in these units and calculate the mass in grams.

Question 2

(a) (i) Most candidates were able to recall the equation and evaluate it correctly. The most common error was to omit the unit or give an incorrect unit for the spring constant. It was acceptable to give the answer in either N/cm or N/m.

(ii) The majority of candidates were able to place a mark at the end of the straight section of the line. Candidates were expected to be precise with the placing of such a mark and marks on the curved section of the line were not accepted. Marks showing a range between two places along the line were also not accepted.

(b) (i) Credit was given for arrows drawn below the horizontal and to the left of vertically down from the car (in other words diagonally). The strongest candidates understood that motion in a circular path is due to a force perpendicular to the motion and drew their arrows pointing radially inwards. Many drew arrows pointing outwards which suggested a misunderstanding of the action of a resultant force.

(ii) Many candidates understood that a smaller radius requires an increased force and gave the correct answer.

Question 3

(a) Most candidates correctly recalled the formula $p = mv$ and correctly substituted values to calculate the momentum. A common error was to give an incorrect unit. Whilst the unit of a quantity is not always obvious from the formula (e.g. energy in Joules) the unit for momentum can be found by combining the units from the terms in the formula.

(b) Many candidates were able to gain credit for their use of the conservation of momentum (either stating it in words or by writing a suitable equation in symbols or numbers), or for demonstrating they were able to calculate a speed of the object from the momentum. A significant number of candidates omitted the minus sign for the speed of the ball after it hit the object (it is a negative vector since the ball bounces back). This led to the most common incorrect value for the speed of the object of 0.57 or 0.56 m/s. Candidates may benefit from more practice with questions involving both positive and negative vectors.

(c) The majority of candidates could recall the correct equation for kinetic energy and many were successful in calculating the KE of the object. However they then added this KE to the change in KE of the ball, rather than subtracting it. Weaker candidates often mistakenly attempted to calculate the change in KE of only the ball using the values given in the question, or they carried out calculations to show that the KE of the ball before and after the collision was 4.5 J and 0.2 J respectively. Neither of these gained credit.

Question 4

(a) (i) The term absolute zero was well known by the majority of the candidates. The most common incorrect answer was freezing point. A small number of candidates missed that the question asked for a name and gave the value *–273 °C* which did not gain credit here.

(ii) To be awarded full credit, candidates needed to recall the value for absolute zero, –273 °C and then be able to add it to 77. The most common error was to omit the minus sign giving an incorrect answer of 350 (°C). Occasionally candidates mistakenly multiplied the two values together.

(b) This had been learnt well by many candidates and they were able to say that when the temperature increases, particles have more kinetic energy and the pressure increases. Weaker candidates often stated that this would increase the collisions but a reference to the increased frequency of collisions was required for credit. If the question asks for an answer in terms of particles, it would help candidates if they mention particles explicitly in their answer to make it clear they are not referring to the gas as a whole. Even if a container is not mentioned in the question, candidates should refer to collisions between the particles and the walls or should refrain from talking about collisions between particles. Candidates found it difficult to make the distinction between the force of individual particle collisions with the wall and the total force of the gas on the walls. A few candidates attempted an explanation in reverse stating that if the gas has a higher pressure, it causes the temperature to increase which led to incorrect physics.

(c) Those candidates who wrote down the equation $p_1V_1 = p_2V_2$ or $pV = constant$ and then substituted in the values before rearranging, were usually successful in getting the correct answer. The most common incorrect answer was 120 kPa × 2 = 240 kPa with no attempt at an equation.

Question 5

(a) All candidates made some attempt at drawing the wave crests and the majority drew the crests the same distance apart as the wavelength of the original waves. They needed to recognise that the wavelength of the original wave was the same as the width of the gap and that this would lead to approximate semi-circular arcs. Many drew straight lines or arcs with very little curvature. Some of the arcs were poorly drawn and often the largest crest was irregular. Candidates would have benefitted from using a compass.

(b) Stronger candidates knew that blue light would have a smaller wavelength and drew crests accordingly. This meant that the wave gap was now larger than the wavelength so there should be less divergence of the wave as it diffracts through the gap compared to **(a)**. This was less well known by many candidates. Only the strongest candidates realised this would lead to wave crests with less curvature than in **(a)**. However, completely straight lines were insufficient.

Question 6

(a) Only a minority of candidates knew that the graph should be curved such that *V/I* increases. Many candidates seemed to have some difficulties with this question. The main misconception was that the filament lamp obeyed Ohm's Law, leading to straight line graphs and explanations saying the resistance was constant. Sketches should show key features so candidates needed to remember to label the axes of graph sketches.

(b) (i) Many candidates did not notice the reversed polarity of the cell and power supply and simply added the two voltages getting an answer of 15V instead of 9V.

(ii) All but the weakest candidates were able to apply $I = V/R$ correctly using the correct value of 9 V or their error carried forward value of 15 V from **(i)** to gain full credit. However, a significant number of candidates attempted to calculate the current using a potential difference of 12 V despite having calculated the voltmeter reading as 15 V in **(i)** so only gained partial credit. It was unclear whether they simply disregarded the 3V cell or whether there was some other misconception about the diode or parallel circuit. Candidates were not expected to know that there is a potential difference across the diode.

(iii) Very few candidates recognised that the diode in the reverse direction would block the current in the 2.1 Ω resistor and the answer of 0 (A) was rare. The command word used in this question was 'determine' which may be used as a suggestion to candidates that a calculation is not required. Many candidates attempted to use $I = V/R$.

(iv) Many candidates correctly realised that they needed to add their answers to **(ii)** and **(iii)** to determine the total current through the ammeter. If candidates edit the value of an answer to an earlier question, they should take care to also edit later questions where that value may have been used. Some answers to **(i)** or **(ii)** had clearly been edited but answers to **(iv)** or **(v)** had not been changed to take account of this.

(v) This was generally well answered and many candidates were able to recall and use the equation $P = I \times V$.

Question 7

(a) (i) Many candidates gained partial credit for recognising the need for a radial arrow and stronger candidates knew that it should point inwards. Candidates should take care with their diagrams. Whilst drawing freehand is acceptable, the arrow needed to be straight and should have pointed inwards radially. Arrows drawn parallel to the electric field lines were not acceptable. Arrows should have been long enough to show the direction clearly.

(ii) Whilst many candidates stated that the point X was a positive charge, few mentioned that it was a point charge. Suggestions of particles which would be point charges, e.g. a proton, were accepted. Weaker candidates gave confused answers mixing up electric and magnetic fields e.g. “a positively charged magnet”.

(b) This was answered well with many candidates demonstrating clear understanding that it is the electrons which move when rubbed and not the positive charges. Weaker candidates either wrote that the positive charges move onto the plastic or they contradicted themselves by saying that both negative and positive charges move.

(c) Stronger candidates referred to delocalised or free electrons. Weaker candidates often referred to conductors being made from metal and insulators from plastic or they stated that conductors let current go through more easily. Neither of these answers was awarded credit here. A few candidates mistakenly referred to free atoms.

Question 8

(a) (i) Most candidates attempted an answer for this question and many were awarded partial credit for knowing that the direction of the coil would be clockwise. A few candidates said that the coil would turn to the right or towards the North pole but this was ambiguous since a coil turning both clockwise and anticlockwise would turn to the right. The explanation proved more challenging and answers often lacked detail. Many candidates knew that the direction of the turning effect was related to Flemmings Left Hand Rule, but simply stating this was not enough here. Candidates needed to be able to use the rule to explain which way the force would be acting, since it is the force which determines the direction of the turning effect. Candidates needed to take care to say which part of the coil they were referring to e.g. “the force on the left side will be up”.

(ii) The question asked how the turning effect compared. Candidates were expected to recognise that the turning effect was greater or increased. Many candidates answered in terms of what the effect would be on the coil and said it would be faster which was insufficient. Candidates needed to recall that the measure of a turning effect is called the moment. Turning effect does not refer to the rate at which an object turns or spins.

(iii) If the resistance of the coil is increased whilst the p.d. remains constant, then the current in the coil will decrease, resulting in less turning effect. Many candidates stated that the turning effect would be slower and a few said there would be less current. Candidates needed to recall that the measure of a turning effect is called the moment. Turning effect does not refer to the rate at which an object turns or spins.

(b) Many answers to **(i), (ii)** and **(iii)** showed clear, correct and labelled diagrams. Candidates demonstrated their ability to interpret the graph clearly and applied their knowledge to the rotation of the coil. A few candidates drew a vertical line for the axis for **(ii)** but mistakenly placed the label B at the top and A at the bottom.

Question 9

(a) (i) Many candidates appeared familiar with the use of radiation in smoke alarms. They were able to give alpha as the radiation source, explaining that it is suitable because it is highly ionising or easily stopped by the smoke particles. Candidates were less confident with the half-life of the source. Many omitted to give an answer or gave answers in a range from a few seconds to months.

(ii) Many candidates correctly identified beta as the type of radioactive emission, but their explanations were often simply a statement about the penetration or range of beta radiation in aluminium. Candidates needed to relate their knowledge to the particular situation in the question. Stronger answers indicated that beta particles can pass through thin strips of aluminium but not thicker strips. This indicated that the amount of absorption of beta depends on the thickness. A statement only stating that beta particles can pass through a thin strip of aluminium was insufficient. Very few candidates understood that the half-life should be in years, with many giving an answer of seconds or days. 'Big' or 'long' were insufficient. Candidates should understand that a half-life in terms of years is required otherwise the activity will become low very quickly and the source will have to be replaced too frequently (possibly interrupting the monitoring and creating more issues with waste disposal).

(b) Stronger candidates interpreted the information given and correctly stated that there are too many neutrons in lead-214. Stating that there is a high number of neutrons was insufficient because lead –208 also has a high number. It is the excess number of neutrons which leads to the isotope being radioactive. Insufficient answers often included statements about the nucleon number being higher for lead-214. Many stated that the lead-214 would be unstable but omitted to relate this statement to why the isotope was therefore radioactive.

(c) Many candidates recalled that rocks or buildings were sources of background radiation. Common insufficient answers included space and the sun which were not precise enough for credit. There were a significant number who wrote argon instead of radon. Candidates are advised to use the most significant sources of background radiation listed in the syllabus where possible, rather than brief answers such as medical or industrial.

Question 10

(a) (i)1 The symbol for the Hubble constant was recognised by many candidates, but they needed to take care with the spelling. Spellings which are not reasonably phonetic or with the correct number of syllables may not be awarded credit.

(i)2 Stronger candidates were able to write down the whole equation with H_o as the subject of the formula. Writing down only the right-hand side of the equation was insufficient to show what was being defined. Writing the equation with *d/v* as the subject was insufficient because the question asked for a definition of H_o. Candidates should be aware of what the question is asking for and should take care when writing down equations. A few gave the equation defining the average orbital speed. Weaker candidates did not attempt this question.

(ii) This proved to be one of the most challenging questions on the paper. Only the very strongest candidates were able to give the correct answer of per second or s^{-1}. Hertz was insufficient in this instance. The most common incorrect answer was seconds. A few candidates correctly derived the unit using the units for the other quantities in the equation.

(iii) Few candidates could correctly calculate the age of the universe using $1/H_o$ even if they remembered they needed to find the inverse of H_o. Some candidates thought the answer would be $2.2 \times 10^{+18}$ s. A common mistake was to use *d/v* substituting in the value of a light year for *d* and the speed of light for *v*. Others calculated the correct answer but mistakenly thought their answer was in years, so attempted to convert it into seconds. A few candidates simply quoted 4.5 billion years which is the (approximate) age of formation of the solar system. Those who tried converting 13.8 billion years into seconds ended up with a value of 4.4×10^{17} s which was insufficient because it is different, to two significant figures, to the value determined using H_o, as asked for in the question. Candidates needed to take care to read the question carefully and not just quote memorised values. Some candidates made no attempt at this question.

(b) Most candidates gained credit for knowing that CMBR came from (just after) the Big Bang. It should be noted that CMBR was not formed at the Big Bang Theory. Some answers appeared confused with red shift, stating that CMBR can be detected from dead galaxies moving away or distant galaxies and others said that it was from the sun. The command word for this question was 'state', so there was no need for explanations of how CMBR formed or why it is now in the microwave region.

PHYSICS

Paper 0625/51
Practical Test

Key messages

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

General comments

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

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

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

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

Comments on specific questions

Question 1

(a) Most candidates recorded realistic *a* and *b* values and gave them to the nearest mm.

(b) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates chose a scale that resulted in the plots occupying too small a proportion of the graph grid. Plotting was generally accurate. Candidates should use neat crosses for the plots, or neatly circled dots so that the accuracy of the plotting is clear. Most candidates obtained a realistic set of readings that resulted in plots producing a 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.

(c) 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.

(d) Candidates were expected to correctly calculate 2*G* and include the unit, N.

(e) Here candidates were expected to comment on their experience of doing the experiment. The most obvious response was that it was difficult to obtain exact balance (due to the instability of the arrangement) but other relevant comments were also given credit.

Question 2

(a) Most candidates recorded a realistic current with the unit, A and a set of increasing potential differences. The calculations of resistance *R* and the ratio R / l were completed successfully by many candidates. The units for length, cm, potential difference, V and resistance, Ω were given correctly by most candidates but a significant number appeared to have missed the instruction to complete the column headings. Candidates were expected to deduce the unit for R / l from the units given for *R* and l.

(b) Candidates were expected to write a conclusion that matched the results. For a correctly worked experiment, the resistance increases with length. The justification needed to include results quoted from the table.

(c) Candidates were expected to obtain a value for R_2 that was double the resistance at length 100cm, within ± 10 per cent. This could be deduced in a variety of ways and all suitable methods of working were given credit.

Question 3

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

(b) In the table, candidates were expected to record two values for *v* with the second value smaller than the first value. Most candidates achieved this. Correct values for the magnification *m* were obtained by many candidates. The two values of image height h_I should both have been greater than h_O.. A significant number of candidates did not achieve this which was probably due to not moving the screen to the position giving the most clearly focused image. Candidates who carried out the experiment with care and accuracy accurately obtained values of h_I/h_O equal to *m* within ± 10 per cent.

(c) (i) Here candidates were expected to write a statement matching their results and to justify the statement by quoting the appropriate results from the table.

(ii) Candidates were expected to state that extra results were required. Some answers were too vague. Candidates were required to make it clear that different readings are required, not the same value for *u* repeated several times.

A few candidates gained full credit for stating that at least five different readings should be used.

Question 4

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

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

Many candidates stated that a stopwatch was required for the investigation. Candidates needed to refer to measuring the time taken for all the water to evaporate whilst being heated. Then candidates needed to explain that the process should be repeated with either different volumes of water or different distances between the heater and the water surface. A vague reference to repeats was not sufficient as it was not clear whether the candidate was referring to using different volumes or heights or repeating the measurements with the same volume or height.

Some candidates assumed that a cooling experiment with temperatures recorded at fixed time intervals was required with many of these not continuing until all the water had evaporated. Although this was the wrong investigation, credit was awarded where possible for relevant answers, for example, for the control of variables.

Candidates needed to specify a variable to keep constant – either the height of the heater or volume of water depending which of those was chosen in the method. Credit was also given for a second possible variable to keep constant. Room temperature, surface area of the water, avoidance of draughts were among the relevant suggestions.

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

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

PHYSICS

Paper 0625/52
Practical Test 52

Key messages

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

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

Some candidates found it challenging to choose an appropriate scale to plot their graphs and in drawing a best-fit line to display their data.

Many candidates seemed less able to derive conclusions backed up by evidence, or to present well thought out conclusions.

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

General comments

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

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

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

Comments on specific questions

Question 1

(a) Almost all candidates recorded a sensible value in the table for the time t for 10 oscillations for the pendulum of length d = 50.0 cm. The period T of the pendulum was usually calculated correctly.

The calculation of T^2 caused more problems, with a significant minority of candidates calculating the value of $2T$ instead of T^2. Only stronger candidates gave s^2 as the unit for T^2 in the table. Most candidates gave the unit s or omitted it completely.

(b) Candidates were required to repeat the exact same procedure already carried out in **(a)**, but with the length of the pendulum increased to d = 100.0 cm. The same comments as in **(a)** also apply here.

(c) Most candidates found this question very demanding and did not recognise how they could use the results they had obtained in **(a)** and **(b)** to test the suggestion that T^2 is directly proportional to d. The most common misconception was that because the value of T^2 increased as the value of d increased, then the two quantities were directly proportional.

Acceptable responses seen were:
1. Calculate the ratio T^2 / d (or the reciprocal of this) for the pairs of values and see if they are equal.
2. Plot a graph of T^2 against d. If the quantities are directly proportional the graph will be a straight line passing through the origin.

(d) Few candidates suggested the use of a fiducial aid, such as a set-square, to help them measure the length of the pendulum accurately. Of those who did, even fewer were able to describe how to do this, or to follow the suggestion given in the question, and then drew a diagram to show how this might be done.

(e) There were very few correct answers to this question. Many candidates realised that the reaction time of the person performing the experiment was involved in the answer. Almost all of these candidates incorrectly thought that timing 10 oscillations rather than just 1 oscillation would reduce the human reaction timing error.

Acceptable responses seen were:
1. Timing 10 oscillations reduces the effect of reaction timing errors.
2. Timing 10 oscillations reduces the percentage error.
3. The reaction time error is spread over 10 oscillations/a longer time.

Question 2

(a) Almost all candidates recorded a sensible value for the current in the resistance wire when the switch was closed. Occasionally the unit of current was omitted.

(b) Most candidates performed the experiment correctly and produced a fully completed table of results. In most cases, the potential difference across the wire was recorded to a precision of at least 0.1 V, and the values of potential difference increased as the length of resistance wire increased. The calculation of the resistance of the different lengths of wire was usually correct but occasionally candidates incorrectly rounded their final answer. However, many candidates recorded their resistance values in the table to a consistent number of significant figures. Values given to a consistent 2 or a consistent 3 significant figures were accepted.

(c) The graph axes were almost always labelled and the correct way around. There was little evidence of the use of scales that increased in inconvenient increments, such as 3 or 7. Choosing such scales makes the points much harder to plot by candidates and more difficult for these plotted points to be seen clearly. Point-plotting was accurate, with most candidates placing their dot or cross within one-half of a small graph square of the exact location of the point.

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

(d) Most candidates knew the method required to find the gradient of a straight line. As expected, candidates who drew a large triangle to determine the gradient of their graphs obtained the most accurate values for the gradient of the line. In a number of cases there was no clear indication on the graph of how the information used to determine the gradient had been obtained, despite the instruction given to indicate this.

Question 3

(a) Most candidates recorded a sensible value for the temperature of the room. Temperatures recorded ranged from 18 °C to 35 °C.

(b) (i) Again, the initial value at t = 0 recorded for the temperature of the hot water θ was realistic, with values ranging from 70 °C to 85 °C. The temperatures of the hot water, taken at 30s intervals as it cooled, were almost always recorded and all candidates ended up with seven sets of readings.

(ii) The column headings were usually completed correctly. Only the unit 's' was allowed and the unit 'sec' for t was not accepted. Similarly, only the unit °C was allowed. 'C' and 'C°' were not accepted as units for θ.

(c) The simple subtraction calculations for the decrease in the temperature of the hot water over the different time intervals stated were almost always correct.

(d) (i) Most candidates agreed with the suggestion that the decrease in the temperature of the hot water over 90 s was greater when its starting temperature was greater. However, most of these candidates ignored the instruction to refer to their own results when justifying the statement. Few candidates quoted and used results from their tables to justify their answers.

(ii) Only stronger candidates understood the requirements of this question that the phrase 'continue the experiment' in the question meant that that the cooling time of the hot water in this experiment should be extended. The intention was that the cooling time of the hot water be extended until the temperature became close to room temperature or stopped decreasing. Most candidates suggested repeating the experiment at a higher starting temperature of the hot water. Partial credit was awarded for answers which stated this.

Question 4

Credit was available for drawing a labelled diagram to show the arrangement of the apparatus. A diagram showing the lens between the object and the screen, and a colour filter placed somewhere between the source of illumination and the lens was expected. At least one label was expected on the diagram.

Further credit was then available for giving a brief explanation of how the investigation would be carried out.

Most candidates realised that the object distance u and the image distance v needed to be measured. Far fewer candidates described any practical detail of actually locating the image. Only stronger candidates stated that the lens/screen needed to be moved until a focussed/sharp image of the object was obtained on the screen. Those candidates who did were very systematic in their methods. Most candidates stated that the values obtained for u and v needed to be inserted into the given equation so that the focal length of the lens could be calculated.

Candidates were then expected to state that the procedure must be repeated for (at least 3 more) different coloured filters. Credit was awarded here if candidates listed named filter colours that they intended to use. Some candidates included black and white in their colour choices for filters.

Most candidates gained credit by drawing a table of results with clear columns for (filter) colour, u and v, giving units where appropriate. Fewer candidates explained satisfactorily how they would use their results to reach a conclusion because they made predictions about the outcome. An answer such as "compare the results to see if/how a change in filter colour affects the focal length" was expected. Many stronger candidates also suggested plotting a bar graph/chart of focal length against colour.

PHYSICS

Paper 0625/53
Practical Test

Key messages

- Candidates need to have a thorough grounding in practical work during the course and should have had significant experience in carrying out experiments. This should include knowledge of 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 that explanations need to be based on data with practical, rather than theoretical, considerations being taken. These techniques will be tested in the paper.
- 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 calculations, with the correct units, should always be shown.
- All questions should be read carefully so that appropriate responses are always given.

General comments

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

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

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

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

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

Comments on specific questions

Question 1

(a) (i) Most candidates correctly measured m_1, m_2 and V_1 and correctly calculated their value of m_3.

(ii) Most candidates correctly calculated the density from their results, but some omitted a unit.

(iii) Only stronger candidates answered this correctly. Other candidates were too focussed on errors arising from poor experimental practice (e.g. not reading perpendicular to the scale/broken equipment) rather than an inaccurate measurement (e.g. uneven sand level/scale too large on measuring cylinder).

(b) (i) Most candidates correctly measured V_2.

(ii) Almost all candidates gained credit here. The most common error was an arrow pointing to the top of the meniscus.

(iii) Most candidates correctly calculated this density. Calculations needed to be consistently shown to either 2 or 3 significant figures.

(c) (i) Only stronger candidates answered this correctly. Other candidates did not realise that there were air gaps between the sand particles. Candidates often referred to the difficulty in measuring the dimensions of a single grain of sand.

(ii) This question caused problems for most candidates who had not answered **(i)** correctly. Many candidates incorrectly stated that the sand soaked up the water rather than filled the air gaps.

Question 2

(a) (i) Most candidates correctly stated the temperature.

(ii) Most candidates recorded the temperature to an accuracy of 1 °C. Some candidates did not allow the thermometer to rise to its maximum value before starting to take readings.

(b) (i) Most candidates correctly measured this temperature.

(ii) Most candidates correctly recorded their results showing a slower rate of cooling.

(c) Well-written responses were seen from many candidates for the initial credit. However, many candidates did not justify their statement by referring to the differences in the change in temperatures over the total time and by quoting figures from their results.

(d) There were many correct calculations, but some candidates stated inaccurate units or omitted them.

(e) Many candidates gained credit here for either stating 'the same volume of water' or 'the same starting/initial temperature'.

(f) A large range of answers was seen here with many candidates not gaining credit due to a lack of detail in their answer. The most common correct answer was the use of a water bath with the temperature being kept constant.

Question 3

(a) (i) Most candidates recorded 5 values with decreasing values of v. Some candidates did not consistently give their answers to the required 1 decimal place.

(ii) Almost all candidates understood the general procedure. However, there was a lack of precision in many answers. Most candidates recognised that the screen should be moved but did not state that it should be moved slowly. Many candidates did not realise that the screen should be moved back and forth.

(b) Almost all candidates answered corrected with an answer to 2 or 3 significant figures.

(c) All candidates understood how to sketch a graph, with almost all using correct axes with units. A few candidates did not use the correct vertical scale. Most candidates plotted their points accurately. A number of candidates did not take enough care when drawing their graphs. Too many thick lines were seen along with large blobs for the points. Candidates must never assume that their graph will automatically pass through the origin.

(d) (i) There were many correct readings from the y-axis intercept as the graph did not pass through the origin.

(ii) Most candidates showed evidence of a triangle method to score initial credit. However, many candidates did not add units to their calculations.

Question 4

It is essential that candidates use the bullet points as guidance when producing their plan. The candidates that did usually gave better responses.

A significant number of candidates did not use the correct symbol for a variable resistor, with many using the symbol for a thermistor instead.

Most candidates recognised that both light intensity and current were the relevant variables, but many did not explicitly state that the current needed to be measured.

Most candidates knew that they needed to repeat the current readings, with some recognising that five was an optimum number. Very few candidates repeated each measurement and took an average.

Many candidates did not state any variable that should remain constant (e.g. room light level or distance from lamp to light meter).

Most candidates realised that a table was required but some did not state the unit for current.

A greater number of candidates successfully compared the relationship between the independent (current) and dependent (light meter reading) variables, most often by stating the use of a graph with the appropriate axes. A comparison not a conclusion was required, i.e. whether the readings in the table showed that a change in current produced a change in light intensity.

PHYSICS

Paper 0625/61
Alternative to Practical

Key messages

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

General comments

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

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

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

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

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

Comments on specific questions

Question 1

(a) Most candidates recorded *a* correctly.

(b) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates chose a scale that resulted in the plots occupying too small a proportion of the graph grid. Plotting was generally accurate. Candidates should use neat crosses for the plots, or neatly circled dots so that the accuracy of the plotting is clear. Most candidates obtained a realistic set of readings that resulted in plots producing a 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.

(c) 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.

(d) Candidates were expected to correctly calculate $2G$ and include the unit, N. Candidates who had plotted the graph with care and accuracy obtained a value within the tolerance allowed.

(e) Here candidates were expected to comment on their experience of doing similar experiments during their course of study. The most obvious response was that it was difficult to obtain exact balance (due to the instability of the arrangement) but other relevant comments were also given credit.

(f) Candidates were expected to write about balancing the rule (with no loads) on the pivot and the balance point indicating the centre of mass.

Question 2

(a) Most candidates recorded the current and potential difference correctly. The calculations of resistance R and the ratio R / l were completed successfully by many candidates. The units for length, cm, potential difference, V and resistance, Ω were given correctly by most candidates but a significant number appeared to have missed the instruction to complete the column headings. Candidates were expected to deduce the unit for R / l from the units given for R and l.

(b) Candidates were expected to write a conclusion that matched the results. For correctly worked results, the resistance increases with length. The justification needed to include results quoted from the table.

(c) Candidates were expected to obtain a value for R_2. This could be deduced in a variety of ways and all suitable methods of working were given credit. The answer was expected to be quoted to one or two significant figures as the question asked for an estimate.

Question 3

(a) Most candidates obtained a value for h_O within the acceptable range and the majority of these answers included the appropriate unit (cm or mm). Some candidates appeared to have measured the height of the illuminated object on **Fig. 3.1** instead of on **Fig. 3.2** as requested.

(b) Most candidates measured u correctly**.** Many candidates deduced the value of V correctly, but some did not include their working. In the table, the correct value for the magnification m was obtained by many candidates. The value of h_I / h_O needed to be given to two significant figures.

(c) (i) Here candidates were expected to write a statement matching the results and to justify the statement by quoting the appropriate results from the table.

(ii) Candidates were expected to state that extra results are required. Some answers were too vague. Candidates were required to make it clear that different readings are required not the same value for u repeated several times. Only a few candidates went on to state that at least five different readings should be used.

Question 4

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

A concise explanation of the method was required. Candidates needed to concentrate on the readings to be taken and the essentials of the investigation. It may have benefitted candidates to plan their table of readings before writing the method to help them to consider the measurements that needed to be taken to address the subject of the investigation.

Many candidates stated that a stopwatch was required for the investigation. Candidates needed to refer to measuring the time taken for all the water to evaporate whilst being heated. Then candidates needed to explain that the process should be repeated with either different volumes of water or different distances between the heater and the water surface. A vague reference to repeats was not sufficient as it was not clear whether the candidate was referring to using different volumes or heights or repeating the measurements with the same volume or height.

Some candidates assumed that a cooling experiment with temperatures recorded at fixed time intervals was required with many of these not continuing until all the water had evaporated. Although this was the wrong investigation, credit was awarded where possible for relevant answers, for example, for the control of variables.

Candidates needed to specify a variable to keep constant – either the height of the heater or volume of water depending on which of those was chosen in the method. Credit was also given for a second possible variable to keep constant. Room temperature, surface area of the water and avoidance of draughts were among the relevant suggestions.

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

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

PHYSICS

Paper 0625/62
Alternative to Practical 62

Key messages

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

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

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

Some candidates found it challenging to choose an appropriate scale to plot their graphs and in drawing a best-fit line to display their data.

Candidates seemed to be less able to derive conclusions from given experimental data and justify them.

General comments

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

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

Most candidates were well-prepared, and the range of practical skills being tested proved to be accessible to the majority of the candidature. Most candidates demonstrated that they were able to draw upon their own personal practical experience to answer questions. No parts of any question proved to be inaccessible to all candidates, and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly, record measurements clearly and perform calculations accurately and correctly. Units were well known and were invariably included.

Comments on specific questions

Question 1

(a) (i) Almost all candidates recorded the correct reading in the table on the stop-watch for the time t for 10 oscillations for the pendulum of length d = 50.0 cm.

(ii) The period T of the pendulum was usually calculated correctly.

(iii) The calculation of T^2 was more challenging, with a significant minority of candidates calculating the value of $2T$ instead of T^2.

(iv) Most candidates inserted the correct units for *d*, *t* and *T* in the table, but only stronger candidates gave s^2 as the unit for T^2. Most candidates gave the unit s or omitted it completely.

(b) The table for **(a)** also contained the readings and results for a pendulum whose length had been increased to *d* = 100.0 cm. Most candidates found this part very demanding and did not recognise how they could use the results they had obtained in **(a)** and those given in **(b)** to test the suggestion that T^2 is directly proportional to *d*. The most common misconception was that because the value of T^2 increased as the value of *d* increased, then the two quantities were directly proportional.

Acceptable responses seen were:

1. Calculate the ratio T^2 / d (or the reciprocal of this) for the pairs of values and see if they are equal.
2. Plot a graph of T^2 against *d*. If the quantities are directly proportional the graph will be a straight line passing through the origin.

(c) The were very few correct answers to this question. Many candidates realised that at least another three additional values of *d* would be required if a graph was to be plotted. Only a small minority of these candidates chose suitable values for the additional lengths required. Most candidates saw that the first two lengths chosen were 50.0 cm and 100.0 cm and listed their additional values in arithmetical progression, i.e., 150.0 cm, 200.0 cm, 250.0 cm. They did not consider that these additional lengths would be far too big to use in the context of a pendulum experiment in a school laboratory. Only values of length between 10.0 cm and 100.0 cm were accepted here.

(d) Few candidates suggested the use of a fiducial aid, such as a set-square, to help them measure the length of the pendulum accurately. Of those who did, even fewer were able to describe how to do this, or to follow the suggestion given in the question, and then drew a diagram to show how this might be done.

(e) There were very few correct answers to this question. Many candidates realised that the reaction time of the person performing the experiment was involved in the answer. Almost all of these candidates incorrectly thought that timing 10 oscillations rather than just 1 oscillation would reduce the human reaction timing error.

Acceptable responses seen were:

1. Timing 10 oscillations reduces the effect of reaction timing errors.
2. Timing 10 oscillations reduces the percentage error.
3. The reaction time error is spread over 10 oscillations/a longer time.

Question 2

(a) (i) The reading on the ammeter was recorded correctly by the majority of candidates. Common incorrect answers were 0.46 A and 3.4 A.

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

(b) (i) The calculation of the resistance of the different lengths of wire was usually correct, but occasionally candidates incorrectly rounded their final answer. Most candidates recorded their resistance values in the table to a consistent number of significant figures. Values given to a consistent 2 or a consistent 3 significant figures were accepted.

(ii) The column headings were completed with correct units by the majority of candidates.

(c) The graph axes were almost always labelled and the correct way around. There was little evidence of the use of scales that increased in inconvenient increments, such as 3 or 7. Choosing such scales makes the points much harder to plot by candidates and more difficult for these plotted points to be seen clearly. Point-plotting was accurate, with most candidates placing their dot or cross within one-half of a small graph square of the exact location of the point.

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

(d) Most candidates knew the method required to find the gradient of a straight line. As expected, candidates who drew a large triangle to determine the gradient of their graphs usually obtained values for the gradient of the line within the allowed tolerance of 2.8 to 3.2. In a number of cases there was no clear indication on the graph of how the information used to determine the gradient had been obtained, despite the instruction given to indicate this.

Question 3

(a) The value of the room temperature was almost always read correctly as 22 °C from the scale of the thermometer. Where the scale was misread, the most common incorrect value given was 20.2 °C.

(b) (i) Most candidates recorded correct values of time *t* from 0 to 180, increasing in increments of 30. Those candidates who omitted the first value of 0 and started their time values at 30 and then continued until 210 had significant issues in **(c)(i)** and **(ii)**, as they did not have a value of temperature for $t = 0$ to work from.

(ii) The column headings were usually completed correctly. Only the unit ‘s’ was allowed and the unit ‘sec’ for *t* was not accepted. Similarly, only the unit °C was allowed. ‘C’ and ‘C°’ were not accepted as units for θ.

(c) The subtraction calculations for the decrease in the temperature of the hot water over the different time intervals stated were almost always correct.

(d) (i) Most candidates correctly agreed with the suggestion that the decrease in the temperature of the hot water over 90 s was greater when its starting temperature was greater. However, most of these candidates ignored the instruction to refer to their own results when justifying the statement. Few candidates quoted and used results from their tables to justify their answers.

(ii) Only stronger candidates understood the requirements of this question that the phrase ‘continue the experiment’ in the question meant that that the cooling time of the hot water in this experiment should be extended. The intention was that the cooling time of the hot water be extended until the temperature became close to room temperature or stopped decreasing. Most candidates suggested repeating the experiment at a higher starting temperature of the hot water. Partial credit was awarded for answers which stated this.

(e) Only stronger candidates were able to use the trend displayed by the temperature values in the table to estimate the temperature of the water after cooling for a further 90 s. A common incorrect answer was room temperature / 22°C.

Question 4

Credit was available for drawing a labelled diagram to show the arrangement of the apparatus. A diagram showing the lens between the object and the screen and a colour filter placed somewhere between the source of illumination and the lens was expected. At least one label was expected on the diagram.

Further credit was then available for giving a brief explanation of how the investigation would be carried out.

Most candidates realised that the object distance *u* and the image distance *v* needed to be measured. Far fewer candidates described any practical detail of actually locating the image. Only stronger candidates stated that the lens/screen needed to be moved until a focussed/sharp image of the object was obtained on the screen. Those candidates who did were very systematic in their methods. Most candidates stated that the values obtained for *u* and *v* needed to be inserted into the given equation so that the focal length of the lens could be calculated.

Candidates were then expected to state that the procedure must be repeated for (at least 3 more) different coloured filters. Credit was awarded here if candidates listed named filter colours that they intended to use. Some candidates included black and white in their colour choices for filters.

Most candidates gained credit by drawing a table of results with clear columns for (filter) colour, u and v, giving units where appropriate. Fewer candidates explained satisfactorily how they would use their results to reach a conclusion because they made predictions about the outcome. An answer such as “compare the results to see if/how a change in filter colour affects the focal length” was expected. Many stronger candidates also suggested plotting a bar graph/chart of focal length against colour.

PHYSICS

Paper 0625/63
Alternative to Practical

Key messages

- Candidates need to have a thorough grounding in practical work during the course and should have had significant experience in carrying out experiments. This should include knowledge of 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 that explanations need to be based on data with practical, rather than theoretical, considerations being taken. These techniques will be tested in the paper.
- 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 calculations, with the correct units, should always be shown.
- All questions should be read carefully so that appropriate responses are always given.

General comments

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

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

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

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

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

Comments on specific questions

Question 1

(a) (i) Almost all candidates gave the correct answer.

(ii) Almost all candidates correctly calculated the density, giving their answer to the required 2 or 3 significant figures and with the correct units of g / cm^3.

(b) (i) Almost all candidates answered this question correctly. The most common error was reading to the top of the meniscus.

(ii) Most candidates gave the correct answer. However, some candidates gave their answer to 2 significant figures with incorrect rounding. It is essential that calculated answers are given to a consistent number of significant figures, usually 2 or 3.

(iii) Most candidates correctly pointed the arrow to the bottom of the meniscus.

(c) (i) Only stronger candidates answered this correctly. Other candidates did not realise that there were air gaps between the sand particles. Candidates often referred to the difficulty in measuring the dimensions of a single grain of sand.

(ii) This question caused problems for candidates who had not answered **(i)** correctly. Many candidates incorrectly stated that the sand soaked up the water rather than filled the air gaps.

(d) Only stronger candidates answered this correctly. Other candidates were too focussed on errors arising from poor experimental practice (e.g. not reading perpendicular to the scale/broken equipment) rather than an inaccurate measurement (e.g. uneven sand level/scale too large on measuring cylinder).

Question 2

(a) Most candidates correctly stated the temperature.

(b) The majority of candidates gained credit for ‘read the scale perpendicularly/at eye level’ or ‘not letting the thermometer touch the sides’.

(c) Well-written responses were seen from many candidates for the initial credit. However, many candidates did not justify their statement by referring to the differences in the change in temperatures over the total time and by quoting figures from their results.

(d) There were many correct calculations, but some candidates stated inaccurate units or omitted them.

(e) Many candidates gained credit here for stating ‘the same volume of water’, ‘the same starting/initial temperature’ or’ ‘surface area of the beaker’. Some candidates did not gain further credit because they did not clearly state the starting or initial temperature.

(f) (i) Most candidates correctly understood that R would decrease because the temperature has increased, but very few recognised the significance of 49 °C (compared to the warm beaker at 48 °C).

(ii) A large range of answers was seen here with many candidates not gaining credit due to a lack of detail in their answer. The most common correct answer was the use of a water bath with the temperature being kept constant.

Question 3

(a) Almost all candidates understood the general procedure. However, there was often a lack of precision in answers which limited the credit that could be awarded. Most candidates recognised that the screen should be moved but did not state that it should be moved slowly. Many candidates did not realise that the screen should be moved back and forth.

(b) Almost all candidates gained credit with an answer to 2 or 3 significant figures.

(c) All candidates understood how to sketch a graph, with almost all using correct axes with units. A few candidates did not use the correct vertical scale. Most candidates plotted their points accurately. A number of candidates did not take enough care when drawing their graphs. Too many thick lines were seen along with large blobs for the points. Candidates must never assume that their graph will automatically pass through the origin.

(d) (i) There were many correct readings from the y-axis intercept as the graph did not pass through the origin.

(ii) Most candidates showed evidence of a triangle method for initial credit. However, many candidates did not add units to their calculation.

(iii) Very few candidates gained credit for ‘darkened room’.

Question 4

It is essential that candidates use the bullet points as guidance when producing their plan. The candidates that did usually gave better answers.

A significant number of candidates did not use the correct symbol for a variable resistor, with many using the symbol for a thermistor instead.

Most candidates recognised that both light intensity and current were the relevant variables, but many did not explicitly state that the current needed to be measured.

Most candidates knew that they need to repeat the current readings with some recognising that five was an optimum number. Very few candidates repeated each measurement and took an average.

Many candidates did not state any variable that should remain constant (e.g. room light level or distance from lamp to light meter).

Most candidates realised that a table was required but some did not state the unit for current.

A greater number of candidates successfully compared the relationship between the independent (current) and dependent (light meter reading) variables, most often by stating the use of a graph with the appropriate axes. A comparison not a conclusion was required, i.e. whether the readings in the table showed that a change in current produced a change in light intensity.