PHYSICS

Paper 0625/12
Multiple Choice (Core)

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

General comments

Many candidates performed well across the paper. Candidates should ensure they read questions carefully so that they give appropriate responses.

Comments on specific questions

Question 1

Most candidates answered this question correctly.

Question 9

Most candidates understood how to transpose a simple formula, which is an essential skill for the study of the subject.

Question 10

Stronger candidates answered this correctly. However, the most popular option was **B**, from those who knew that the boiling temperature of water is 100 degrees of some sort. The next most popular option was **C**, from candidates who recognised that ‘K’ indicated the kelvin scale, and that the number 273 was somehow involved.

Question 14

Some candidates appeared not to have noticed the emboldened 'not' in this question.

Question 17

Although stronger candidates got this right, this was challenging for many candidates, possibly as they did not understand the word 'propagating'. This is a syllabus word, and candidates should be taught it.

Question 18

Most candidates understood that total internal reflection occurs when the angle of incidence is greater than the critical angle. Some thought that it occurs when light in air encounters glass than when light in glass encounters air. The 'internal' reference in the phrase 'total internal reflection' provided the clue.

Question 22

This question was challenging for many candidates. The correct approach was to transpose $v = s / t$ to obtain $t = s / v$, and then to recall that the speed of sound to one significant figure (taking a cue from the responses) is 300 m / s. Substitution then yields t = 0.25 s, which needed to be doubled to take account of the there-and-back feature of most questions involving echoes.

Question 26

Some candidates thought that there would be no current at the site of ammeter 3. Current does not get 'used up'. Current is a flow of charge, and charge is conserved. The current splits at a junction and, because the lamps are identical, half goes through each lamp, with the result that ammeter 2 records 0.15 A. Even some stronger candidates appeared to misunderstand this point.

Question 32

As many candidates chose **A** as chose the correct answer (**B**). The most important point of the concept of background radiation is that it is detected even when there is no source present.

Question 37

Option **A** was a popular choice, presumably from candidates who knew that the two rocky planets are the two closest to the sun, and who therefore chose the two with the lowest mantissas, ignoring the exponents.

Question 40

More than a third of the candidates chose **C**. Those who knew the answer (**D**) were drawn from the whole ability range.

PHYSICS

Paper 0625/22
Multiple Choice (Extended)

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

General comments

Many questions were very well answered, indicating that candidates had a strong understanding of the physical principles involved.

Comments on specific questions

Question 6

Some candidates appeared to think of the principle of moments as effectively 'sum of the moments on the left-hand side of the pivot = sum of the moment's on the right-hand side', and so selected option **C**. Others were confused by the distance *c* (which is not a 'perpendicular distance to the pivot') and incorrectly selected option **A**. Stronger candidates recognised **D** as the correct response.

Question 14

Option D described the situation for a gas, but many candidates selected it. In a liquid the particles are mostly as close to each other as in a solid, and vibrate in a similar way, subject to the same strong forces during the course of their vibrations. However, there are gaps in the structure, allowing the particles to move from one position to another, which is how the liquid can change its shape, so the answer was option **B**.

Question 17

Some weaker candidates selected option **B**, believing the image in a plane mirror to be real.

Question 18

The syllabus specifies the lower limit of human hearing to be 20 Hz. The elephant's lower limit of 10 Hz is outside this range and therefore, is inaudible to humans. However, some candidates selected option **B**.

Question 22

Short-sightedness causes distant objects to appear blurred, while close objects can be seen clearly. This is because parallel light is bent too much, so it needs to be corrected by a diverging lens to 'unbend' it a little before the eye does its bending. Therefore, option **C**, selected by some candidates, was incorrect.

Question 23

This question required careful thought. In the right-hand diagram, X appears heavier because it is being pushed downwards so the charges on X and Y must be the same.

Question 26

Nearly all candidates realised that P is a neutral point. When the field lines emerge from the left-hand N pole in diagram 2 they splay out as they pass Q and then reconverge before entering the S pole of the right-hand magnet. Therefore, they are closer together at R than at Q. Weaker candidates did not realise this.

Question 27

This question was challenging for many candidates. Many gave option **C** as the answer, probably believing that doubling the length doubles the resistance, and that doubling that diameter halves the resistance, and that the two effects cancel out. But, although it is true that doubling the diameter reduces the resistance, it reduces it by a factor of four, as the resistance is inversely proportional to the area, which is in turn proportional to the square of the diameter. So the overall effect of both changes is to halve the resistance (i.e., option **B**).

Question 33

Only stronger candidates answered this correctly. Candidates should be familiar with the convention that crosses indicate a field directed into the plane of the paper, while encircled dots indicate a field coming perpendicularly out of the paper. Candidates could have, if they wished, confirmed that the diagram was correct by applying the left-hand motor rule, remembering that the second finger (current) needed to point to the left, the moving particles being negatively charged. But all they needed to do was to identify what kind of electric field would attract negative charges (e.g., electrons) towards the bottom of the page, and realise that it would be a field running up towards the top of the page (i.e., option **D**).

PHYSICS

Paper 0625/32
Core Theory

Key messages

- When asked to describe the motion of an object, candidates should refer to the speed or acceleration of the object. They should know that responses such as 'the motion is constant' or 'the motion is increasing' are insufficient.
- Some candidates were unclear about what does or does not count as a significant figure. Centres should encourage candidates not to round to 1 significant figure and should set practice exercises on this topic.
- Some candidates were unclear what is meant by an energy store. Centres should encourage candidates to practise identifying the energy stores in common situations and to practise describing how energy is transferred between the stores.

General comments

Most candidates were able to apply their knowledge and physics understanding to the questions set to produce correct responses.

A high proportion of candidates displayed a good grasp of the English language, and almost all candidates had a sufficient understanding to be able to attempt the questions. However, the use of pronouns, such as 'it' and 'they' without making it clear what these pronouns were referring to, especially in comparison questions, often made responses unclear. Candidates also frequently stated a property had changed but failed to state how it had changed i.e., increased/decreased.

Comments on specific questions

Question 1

(a) Candidates found this item difficult. Many candidates simply stated that the motion was increasing or constant and did not identify whether they meant speed or acceleration.

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

(c) The majority of candidates answered correctly. The most common errors were to give either the time at which the student stopped walking or the time when the student started walking again.

(d) Candidates found this item difficult. The most common error was to state that the acceleration in AB was greater than in CD.

Question 2

(a) The vast majority of candidates answered correctly. The most common error was failing to read the question carefully, and then either multiplying or dividing the two volume readings instead of subtracting to give a volume of 12 cm^3.

(b) The vast majority of candidates gained full credit for this question. The most common error was to give an incorrect unit. Only a very small number recalled an incorrect form of the equation for density.

(c) (i) Most candidates scored at least partial credit. The most common error was failing to recall that the upward force was friction or a resistance force from the water.

(ii) Candidates found this item challenging. Most did not link the downward movement and balanced vertical forces on the metal to state the metal would be falling at a constant speed.

Question 3

(a) The vast majority of candidates gave the correct answer. The most common errors were to either invert the equation for pressure, or to simply multiply the force and the area.

(b) The vast majority of candidates answered correctly. The calculation of the moment of a force was well understood by most candidates.

Question 4

(a) The majority of candidates were able to correctly identify the energy store in the battery as chemical energy. However, a significant number thought that the energy store was electricity or electrical energy.

(b) Most candidates correctly calculated the amount of mechanical work done as 63 J. The most common error was to state that work done = force ÷ distance.

(c) Most candidates correctly calculated the power input as 180 W. However, many did not recall a correct form of the equation for power. A common error was to multiply the time and the energy input.

Question 5

(a) Many candidates correctly described the arrangement and movement of particles in a liquid. Some descriptions lacked clarity and did not differentiate clearly between solids and liquids.

(b) Candidates found this challenging but stronger candidates gained full credit. The most common error was to simply state that the pressure increased but then not to explain in terms of particles why the pressure increased. Others simply gave a description about how the temperature of the gas changed.

(c) Very few candidates gained full credit for a description that included the ideas that the thermal energy is first transferred by infrared radiation through space and the atmosphere and then by conduction through the metal.

Question 6

(a) (i) The majority of candidates identified the amplitude as 30 mm. A common error was to give 60 mm. A significant number of candidates used rulers to measure the amplitude from the paper. Centres should encourage candidates to use the scale on graphs and diagrams to determine readings.

(ii) Candidates found this item challenging but stronger candidates were able to reason from frequency = number of waves sent out per second to give a frequency of 10 Hz.

(b) (i) The vast majority of candidates correctly identified an example of a transverse wave. However, a significant number thought that a sound wave was a transverse wave.

(ii) Stronger candidates were able to give a correct description of the movement of particles in a transverse wave. Common errors were to simply state that the vibrations were fast or that the vibrations went up and down. However, significantly more candidates recognised that the vibrations were perpendicular to the direction of propagation.

Question 7

(a) (i) Only stronger candidates were able to determine 10 cm as the focal length of the lens. A common error was to determine the distance between the two focal points rather that the distance from the centre of the lens to one of the focal points.

(ii) Many candidates gained partial credit for the ray diagram and for identifying the image position. A common error was not drawing the ray through the centre as a continuous straight line. Other candidates did not extend the ray parallel to the principal axis so that it passed through the principal focus.

(b) (i) The vast majority of candidates identified the missing region as X-rays.

(ii) The vast majority of candidates gave a valid use of ultraviolet radiation.

(iii) The vast majority of candidates gave a valid harmful effect of overexposure to ultraviolet radiation. Many who did not answer correctly did not give enough detail with vague answers such as “it is radiation”.

Question 8

(a) Many candidates answered well, with some very clear descriptions of how to identify both the pattern and direction of the magnetic field using either one or more plotting compasses or a combination of iron filings and a plotting compass. However, despite this experiment being on the syllabus for many years, a large number of candidates did not know how to do this.

(b) The majority of candidates answered correctly. The most common error was to give iron as a suitable material.

(c) The majority of candidates identified a valid use for a permanent magnet. However, there were many answers that were too vague for credit, including “in a kitchen appliance” or “in a door” or “picking up metals in a scrapyard”.

Question 9

(a) The majority of candidates answered well. The most common error was to draw the symbol for a fuse or a variable resistor instead of a thermistor. Some candidates added a voltmeter.

(b) (i) The majority of candidates answered correctly with an answer of 27 Ω. Weaker candidates used an incorrect form of the equation $V = I \times R$.

(ii) Many candidates answered correctly. However, a significant number of candidates could not recall the equation $E = V \times I \times t$. Centres are advised to ensure that candidates practise using this equation as it is relatively new to the syllabus.

(c) Most candidates gained credit for stating that the current in the circuit increased, but a significant number did not state that this was due to the resistance of the thermistor decreasing.

Question 10

(a) The vast majority of candidates correctly identified the proton and the electron.

(b) The majority of candidates correctly drew and labelled an atom of lithium. The most common error was not having 3 labelled protons and four labelled neutrons.

(c) Many candidates correctly identified 3 half-lives were needed for the carbon-12 to decay. However, many then divided the half-life time by 3 instead of multiplying. The concept of half-life was not well understood by most candidates.

Question 11

(a) Most candidates answered correctly. It was evident on a number of responses that candidates had learnt a mnemonic to give the order of the eight planets in the Solar System.

(b) Many candidates produced very clearly set out and correct answers or 370 or 367 s to this calculation. The most common error was in rearranging the equation speed = distance ÷ time. Many candidates incorrectly used time = distance × speed.

(c) Many candidates correctly gave a value of gravitational field strength on Venus of less than 9.8 N / kg. However, many failed to clearly state that their value was smaller because the mass of Venus is smaller than the mass of the Earth.

PHYSICS

Paper 0625/42
Theory (Extended)

Key messages

Candidates demonstrated good recall of formulae across the syllabus. Candidates should give numerical answers to an accuracy consistent with data given in the question (usually two significant figures) unless the question gives a specific instruction otherwise. A numerical answer must always have the correct unit.

Expressing answers in standard form requires care. In **Question 2(b)(ii)**, **Question 3(a)(i)** and **Question 4(b)(ii)** answers were often seen expressed to only one significant figure in standard form, e.g., 4×10^5 instead of 4.0×10^5 Pa.

Where a question asks for a definition, candidates must take care to use words precisely, giving an accurate definition. This applied in **Question 4(a)** and **Question 11(b)(i)**.

In questions where candidates are asked to show that a quantity has a particular value, they must state any formula or equation they use, in words or symbols, before substituting in numerical values. This applied in **Question 2(b)(i)**.

Where a question asks for an explanation of physics in a context, candidates should take care to write their answer in the context of the question. This applied in **Question 3(a)(ii)** and **Question 8(b)**.

General comments

Many candidates had prepared well for this examination demonstrating a good understanding across a range of topics within the physics syllabus. Some parts of the space physics topic were not attempted by the weakest candidates, especially in **Question 11**.

This syllabus now requires that candidates take the weight of 1.0 kg to be 9.8 N and (acceleration of free fall = 9.8 m / s^2). On this paper, use of g = 10 N / kg was seen very rarely.

Most candidates showed their working in numerical questions. This allowed them to gain partial credit for correct physics when the final answer was incorrect. If candidates cross out their working, it will not be considered for partial credit.

Comments on specific questions

Question 1

(a) Most candidates accurately described no motion between 3.5 min and 4.5 min. Full credit here required precise expression for each time segment. Between 2.9 and 3.5 min the deceleration is constant, as shown by the straight line with negative gradient. The answer deceleration, on its own, was insufficient. Some candidates described the motion between 0.9 and 2.9 min as constant without stating that it is the speed which is constant.

(b)(i) Many candidates gained full credit here by recalling the formula for kinetic energy and including the unit with their answer. The most common errors were forgetting to square the velocity or giving an incorrect unit, or no unit, in the final answer.

(ii) The simplest method in this question was to use $W = Fd = \Delta E_k$ to calculate the force required to stop the bus. Few candidates took this approach, suggesting it was a less well understood part of the syllabus. Candidates who used other methods, such as $F = ma$ and $a = \Delta v / t$ often forgot to use average velocity when calculating t.

Question 2

(a) The wording of this question gave candidates the choice of defining impulse in words or with a symbol equation. The strongest answers were concise and precise. Impulse equals change in momentum or $F \times t$ were equally valid. Some word definitions were ambiguous e.g., force in a certain time. Weaker candidates often included contradictory statements e.g., impulse is; force into time, rate of change of momentum, force per unit time.

(b) (i) Stronger answers started with the equation, $F = mv / t$, written in words or symbols. The equation was accepted in any form. Use of $F = ma$ was accepted if candidates made it clear that they were using $a = \Delta v / t$ as well. When substituting the numbers in the correct equation, it is best to calculate an unrounded answer first. The final step then shows that this calculated value is correct to the number of significant figures given in the question. Many candidates gave $F = ma$ and omitted a calculation of acceleration. Weaker candidates stated an incorrect equation, e.g., $F = mv$ or did not write an equation in words or symbols.

(ii) The maximum mass that can be lifted by the force in **(i)** is the mass with a weight equal to the force in **(i)**. Using $m = W / g$ and $g = 9.8\,\text{N/kg}$ allowed the maximum mass to be calculated. Candidates who wrote their answer in standard form needed to take care to give the appropriate number of significant figures. In this question, the force was given to two significant figures and so an answer to at least two significant figures was required. A common incorrect approach here was to use the equation $F = ma$ and then substitute the value for v as a.

Question 3

(a) (i) Many candidates recalled the formula $P = F / A$. The correct answer required the calculation of the total area of 4 tyres in contact with the ground. Other common mistakes included giving an answer to only one significant figure or including an incorrect unit or no unit in the final answer.

(ii) Stronger candidates included precise statements about why the air pressure inside car tyres increases when the car is moving. Friction between the road and tyre causes the tyre temperature to increase. Air particles in the tyre gain kinetic energy and collide more frequently with the tyre walls. Many answers were vague, for example that friction increases temperature or that more collisions take place. Weaker candidates often thought that the pressure change was due to compression of the tyre reducing its volume.

(b) Many candidates correctly calculated the maximum number of balloons. Those who did not get full credit usually recalled pV = constant, in some form, to gain partial credit. Weaker candidates were often unable to rearrange their equation correctly or were confused about which pressure value went with which volume. A few candidates made transcription errors when substituting data from the question into a calculation.

Question 4

(a) Stronger candidates clearly stated that the specific heat capacity is the energy transferred per unit mass per unit temperature. Candidates most often expressed this as the energy needed to raise the temperature of 1 kg mass by 1 °C. Some candidates confused a rise of 1 °C with a rise to 1 °C. A definition in symbols is clearer when candidates use symbols given in the syllabus, e.g. T or θ for temperature and t for time. Where candidates use other symbols, they must be defined. Some candidates confused temperature and time.

(b) (i) Almost all candidates recalled the equation $m = \rho V$ to obtain the mass of oil. Occasionally candidates made a transcription error when substituting the volume of oil. Some weaker candidates tried to use an equation with specific heat capacity in this question.

(ii) Candidates usually knew the equation $\Delta E = mc\Delta\theta$ to use for this question. There were a few transcription or arithmetic errors seen. In a symbol equation, ΔT is accepted for $\Delta\theta$. Some weaker candidates used time instead of temperature change in their calculation. Δt is not accepted for $\Delta\theta$. Also, Q is not accepted for E.

(iii) The formula $P = E / t$ was well known. A common mistake was to substitute time in minutes rather than seconds.

Question 5

(a) (i) Stronger candidates gave fully correct answers here. Common misconceptions included suggesting that microwaves sterilise food, optical fibres use ultraviolet and security marking uses infrared.

(ii) Most candidates correctly recalled the speed of radio waves in air. An answer to one significant figure gained credit as the question asked for the approximate value. Candidates should recall and use this value to two significant figures, since this is how it is given in the syllabus. Weaker candidates sometimes confused the speed of radio waves with the speed of sound in air.

(b) (i) Almost all candidates used a ruler to draw crests parallel to the barrier. Many took care to keep the wavelength the same and gain full credit. Common errors were to show a different wavelength. The weakest candidates drew semi-circular waves before the barrier.

(ii) Where a gap is much wider than the wavelength of plane waves, there is little diffraction. The strongest answers showed straight crests to the right of the gap, with short, curved ends. A common error was to draw shallower, curved crests, without a clear straight segment, that touched the barrier above and below the gap.

Question 6

(a) Most candidates used a sharp pencil and ruler to draw the ray accurately and to find the position of the lens. Few candidates were unable to place the lens correctly at the intersection of the ray with the principal axis.

(b) Most candidates drew correct rays from O to their lens position and from the lens to the image. Stronger candidates measured the focal length correctly. Some candidates only gave an answer to 1 significant figure, omitted the unit or did not draw the ray sufficiently parallel to the principal axis to obtain an accurate value for the focal length. Weaker candidates often did not know how to measure the focal length. Several alternative measurements were given, including distances along the principal axis to O or I.

(c) Stronger candidates clearly stated that the image would be virtual and upright. Answers that were not characteristics of an image, e.g. "the image is on the same side of the lens as the object", were ignored. The command word showed that candidates were not expected to determine from **Fig. 6.1** how the magnification of the image changed. A few candidates attempted to compare magnification and often gave contradictory statements, e.g., "image is larger than original image".

Question 7

(a) The correct symbol for a potential divider includes two wire connectors and no gap between the arrow tip and the rectangle. Few candidates drew the correct symbol. A wide variety of different incorrect symbols were seen, and some candidates made no attempt to draw the symbol.

(b) (i) Use of the formula $V_1 / V_2 = R_1 / R_2$ gave stronger candidates the correct value for V_{out}. Common mistakes included inconsistent use of subscripts in the formula and substituting values to give the potential difference across the variable resistor. Candidates who attempted to use $V = IR$ often made mistakes, such as using the full p.d. across the resistance of a single component to find a value for I. A few candidates gave a correct numerical value with the unit of resistance, ohms.

(ii) Most candidates correctly recalled the formula $I = Q / t$ here. A common mistake was incorrect conversion of mA to A. Weaker candidates sometimes rearranged the formula incorrectly.

Question 8

(a) (i) Stronger answers had concentric circles, centred on the wire, and clearly showing a greater difference in radius between the second and third circles than between the first and second circles. Circles drawn freehand, rather than with compasses, often did not show a clear difference in radius. Most candidates correctly indicated the direction of the magnetic field. Some candidates who drew multiple arrows on the field lines contradicted themselves. It is better to place one, correct arrow on each field line.

(ii) Many candidates stated that the magnetic field strength increases and the direction of the field reverses. Weaker candidates sometimes stated only that the magnetic field direction changes, which was insufficient to gain credit.

(b) This question asked candidates to comment on the efficiency of electricity transmission under different conditions. Stronger answers linked:

- high voltage to a small current
- thinner wires to a higher resistance
- efficiency to power loss, using $P=I^2R$
- a bigger effect on efficiency from changes in current.

Most candidates stated that high voltage transmission meant that current is low. Few candidates stated the power loss equation. Very few candidates explained that thinner wires have higher resistance. Many candidates stated general advantages of high-voltage transmission rather than applying their knowledge to the question asked. Common misconceptions included confusion about what lowered the current, suggestions that high voltage caused a higher current or that a faster flow of charge resulted in high resistance.

Question 9

(a) (i) Many candidates stated the correct conclusion that most of an atom is empty space. Candidates who concluded that the nucleus is very small also gained credit. Common incorrect responses referred to alpha particles or nuclei instead of atoms, or concluded that there is lots of empty space between atoms.

(ii) The most common correct response concluded that the nucleus is positively charged and explained that positively charged alpha particles are deflected due to a repulsive force. Some candidates concluded that the nucleus is very small and explained this by the small number of alpha particles which were deflected. Weaker candidates often referred to atoms instead of nuclei or made vague statements, for example that like charges repel instead of stating clearly that alpha particles are positively charged. Explanations often just repeated words and phrases from the question. Some candidates referred to electrons attracting or repelling the alpha particles.

(b) (i) Stronger answers either stated that a neutron changed into a proton or that the nucleus had one more proton and one fewer neutron when a beta particle is emitted. Many candidates gave only half an answer, stating either that the number of protons increased by one or that the number of neutrons decreased by one. Common misconceptions were that the nucleus didn't change or became positively charged.

(ii) Most candidates showed a good understanding of half-life and used this to calculate the mass of strontium remaining after 87 years. Careful reading of the question helped candidates who took this value away from the original mass to give the correct final answer for the mass of strontium that had decayed.

Question 10

(a) (i) Many candidates correctly identified a quarter moon at A or E (some gave both positions) and a full moon at G. Candidates who gained partial credit were more likely to identify the quarter moon position correctly. A common incorrect response for the full moon was position C.

(ii) Many candidates stated that the moon orbits the Earth in approximately a month. Answers were most often given in days. Some candidates confused this question with the length of a day on Earth.

(b) (i) Most candidates stated the correct equation for average orbital speed. Substituting a period in seconds was a common mistake. Some weak candidates used the time value from **10(a)(ii)** as the period here.

(ii) Almost all candidates identified the correct equation to use here. A common mistake was to use the distance from the Sun to Earth in km instead of converting to m. Weaker candidates rearranged the equation incorrectly or were unable to recall the correct equation.

Question 11

(a) Stronger answers stated that in a stable star the inward gravitational force is balanced by an equal and opposite outward force due to the fusion reactions in the star. Some candidates expressed this equilibrium in terms of two pressures balancing. Answers that suggested a force is balanced by a pressure or an energy did not gain credit. A few candidates made contradictory statements such as defining gravitational force as outwards.

(b) (i) This question required a precise answer stating that the Hubble constant is the ratio of recessional speed of a galaxy (or star) to the distance of the galaxy (or star) from the Earth (or observer). Candidates who defined H_0 as the subject of the equation $H_0 = v / d$ without defining v and d gained some credit. Common misconceptions here included reference to the distance travelled by a galaxy or reference to the speed that the Universe is moving away from the Earth. Some candidates gave a use of the Hubble constant, e.g., to estimate the age of the Universe, rather than a definition.

(ii) This question required either an equation with age of the Universe as the subject or the equation $1 / H_0 = d / v$. Common insufficient answers here included writing an equation with H_0 as the subject or writing the term $1 / H_0$ on its own.

(iii) Many candidates correctly evaluated $1 / H_0$ in s. The command word was ‘calculate’ and the answer line had the unit s so there was no credit for recalling a value for the age of the Universe in e.g., years.

PHYSICS

Paper 0625/52
Practical Test

Key messages

- Candidates need to have had a thorough grounding in practical work during the course, including an understanding of the procedures and precautions necessary to produce reliable and accurate results.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. These aspects will be tested at some point in the paper.
- Candidates should practise applying their knowledge of practical work to plan investigations and suggest modifications or improvements to given methods.

General comments

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

- tabulating readings
- plotting graphs
- manipulating data to obtain results
- drawing conclusions from results
- 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 course will be taught so that candidates undertake regular practical work as an integral part of their study of physics. Questions on experimental techniques were answered much more effectively by candidates who showed evidence of having regular experience of similar practical work. This was seen in the good practical details given by some candidates in **Questions 1(d)**, **3(a)** and **3(c)**.

Numerical answers should also be accompanied by an appropriate unit, and this was a requirement in **Questions 1(c)**, **3(a)(iii)** and **3(b).** Appropriate units were also seen in **Table 2.1** and, where necessary, in the results table specified by candidates in **Question 4**.

There will be questions in which candidates are asked to devise approaches to investigations which may or may not be familiar to them or to suggest improvements to methods given in the examination paper. However, these questions can always be answered by careful reading of the question and the logical application of good experimental practice. This was particularly the case for **Question 4**.

Comments on specific questions

Question 1

Most candidates were able to obtain satisfactory data to plot the graph but the questions on practical techniques were challenging for many candidates.

(a) Many candidates obtained 5 pairs of good values for the position of the pivot and the distance *b*, showing careful practical skill and accurate calculation. Decreasing *b* values were generally seen but not always expressed to the nearest mm.

(b) There were many well-drawn, accurate graphs with clearly labelled axes. Scale intervals were usually chosen sensibly with very few impractical values. However, many candidates gave a scale for *a* values which occupied less than half of the *y*-axis. Most candidates recognised that the axes should start at the origin.

Plotting was mostly careful, and many candidates indicated the plots with fine crosses. Small dots are acceptable but are often obscured when the line is drawn through them, making it more difficult for them to be seen. The large dots or thick crosses used by some candidates are not acceptable as the intended value cannot be determined clearly. A sharp pencil should be used for the plots and for the line so that accurate drawing may be achieved, and errors easily corrected.

Many candidates produced a well-judged straight line as indicated by their accurate plots. Only a very small number incorrectly joined points together or diverted the line through the origin when the trend of the plots did not indicate this. Most candidates were able to determine the gradient, showing clearly on the graph that a triangle method had been used.

(c) There were many values for the mass *M* of the metre rule which fell within the expected range, derived from the requirements of the Confidential Instructions. It is important that the Supervisor's results are supplied so that any variation from these requirements can be taken into account and the range of acceptable values adjusted accordingly. Where errors were made, it was generally by omitting the unit of cm or giving an inappropriate unit. Kg was an acceptable unit provided that the value had been recalculated to match.

(d) Very few candidates recognised the technique of measuring the width of the load and positioning each edge at half this value from the correct mark on the metre ruler. Some suggested observing the mark through the 'slit' in the load, indicating that candidates had been supplied with incorrect apparatus as the Confidential Instructions specified that the scale should not be visible through the load.

(e) Only stronger candidates answered this correctly. These candidates referred to the change in the calculated mass of the metre ruler when a piece of clay was added. They either suggested that it was not a suitable change as the mass of the ruler was altered or that it was suitable as the mass of the clay was very small compared to the mass of the ruler. Both responses were acceptable.

Question 2

Many candidates were able to carry out this practical satisfactorily, obtaining a good set of readings leading to accurate calculations.

(a) Most candidates obtained good values for potential difference and current, recording the potential differences to 1 decimal place and the increasing currents to 2 decimal places.

Table 2.1 often contained correct calculations of resistance *R*. Units of V, A and Ω were usually seen.

Although not encouraged, units expressed in words were accepted. A common error was to indicate the current unit as C, presumably coulombs.

(b) (c) Most candidates obtained a decreasing set of resistance values but not all expressed them consistently to 2 or 3 significant figures.

(d) Good calculations were often seen, matching the readings in the table. It was expected that the values of R_A, R_B and R_C should be within 10 per cent of each other, each reflecting the value of one of the identical resistors specified for the circuit. It was an indication of good practical work to see that this was the case for many candidates.

The concept of values being able to be considered as equal when they fall within the limits of experimental accuracy was understood by many candidates and the 10 per cent range of those limits was often quoted in responses. However, there were answers which stated that any difference in values suggests that they cannot be considered as equal.

Some candidates did not quote the values from results as required by the question.

Question 3

Many candidates produced good responses to this question and some careful practical work was seen. It was clear that the quality of response depended on whether this type of experiment was familiar to candidates.

(a) This was not answered well, with many candidates referring to setting up the experiment in a dark room rather than focussing on the technique of moving the screen slowly and/or back and forth. Some candidates incorrectly suggested moving the lens or the object.

Measurements of v, h_O and h_I were carried out well and the calculation of M was generally correct from the recorded results. A very few candidates reversed the equation for magnification.

Most candidates, correctly, did not attach a unit to M but a unit of cm was sometimes seen.

(b) Most values for focal length f_1 fell within the expected range and a unit of cm was often given, generally here but sometimes in **(e)**, which was accepted in either position for credit.

(c) The idea of the student's hand or the ruler obstructing the image was well understood and was a common correct answer, as was the use of a translucent screen to overcome this difficulty. The use of a grid or ruler drawn on the screen was also seen and was an acceptable response.

(d) The measurement of a new image distance for a revised object distance was done well in many cases, with a value less than half of that obtained in the earlier experiment.

(e) Many candidates were able to gain credit here, indicating that they had carried out the practical procedures consistently accurately to obtain a new value of focal length f_2 within 10 per cent of the value of f_1.

(f) Very few correct answers were seen here. It was expected that candidates would recognise f_2 as the more accurate value as f_1 involved measurement of the very much smaller distances h_O and h_I, (with consequent larger per cent uncertainties). Many incorrect responses referred to the different complexities of the calculations or to possible poor practice in the techniques.

Question 4

Many candidates were able to obtain credit for aspects of good practice and planning. The strongest responses showed a logical approach, structured as suggested by the bullet points in the question, with concise sentences which communicated ideas well. Candidates often missed straightforward points if planning was not approached in a sequential way.

The required additional pieces of apparatus of a thermometer and a stopwatch were often seen but one or other was missed in some responses. An indication of cooling rate could only be obtained by use of this apparatus, even if the rate was not calculated in the procedure described.

Many candidates answered well when describing the method, but essential aspects were missed in a few responses.

Credit for method was obtained for: measurement of the independent variable; measurement of the temperature change and measurement of the time period.

The independent variable was accepted as measured thickness of insulation or number of layers of insulation clearly stated.

The temperature change was obtained through measurement of the initial temperature and the final temperature after a measured or stated time. A common error was to omit the measurement of the initial temperature.

Credit was available for an explicit statement that the procedure should be repeated with a different value of independent variable.

Most candidates stated at least one key variable which should be kept constant. Acceptable variables were the initial temperature or the volume of the water. A few candidates stated simply “temperature of water” rather than including ‘initial’.

Many well-considered tables were seen, containing clear columns for readings of independent and dependent variables, with appropriate units. Some candidates omitted units or important columns such as insulation thickness or the raw temperature data which would lead to calculation of temperature difference or rate of cooling.

Candidates needed to check that the table matched the data they were required to record. Some responses incorrectly showed tables which would not accommodate the data needed for cooling curves relating to a number of thicknesses of insulation.

A comment on the analysis of results was expected. The most straightforward responses suggested that results should be compared to see if a change in the insulation thickness produced a change in the cooling rate. This allowed for the eventualities of the cooling rate changing or the cooling rate being unaffected rather than the assumption that there would be a change. Many candidates incorrectly predicted a conclusion instead, often quoting theory to support this.

Mention of a line graph, with suitable axes clearly stated, was sufficient to gain credit for analysis.

Full credit for the question was gained by a few candidates who gave an additional point of good practice. Some of the more common responses suggested taking at least five sets of data to draw a graph or repeating each measurement of the dependent variable and obtaining an average value. However, ‘’repeat the experiment” was not accepted as a suitable response here.

A few candidates gained credit by giving a correct procedure for the calculation of cooling rate from measured data.

PHYSICS

Paper 0625/62
Alternative to Practical

Key messages

- Candidates need to have had a thorough grounding in practical work during the course, including an understanding of the procedures and precautions necessary to produce reliable and accurate results.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. These aspects will be tested at some point in the paper.
- Candidates should practise applying their knowledge of practical work to plan investigations and suggest modifications or improvements to given methods.

General comments

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

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

It is assumed that, as far as possible, the course will be taught so that candidates undertake regular practical work as an integral part of their study of physics. This examination should not be seen as suggesting that the course can be fully and effectively taught without practical work. Some of the skills involved in experimental work, including graph plotting and tabulation of readings, can be practised without actually doing the experiments but there are parts of this examination in which the candidates are asked to answer from their own practical experience.

Questions on experimental techniques were answered much more effectively by candidates who showed evidence of having regular experience of similar practical work. This was seen in the good practical details given by some candidates in **Questions 1(b)(i)**, **2(e)**, **3(a), 3(b)(i)** and **3(e)**.

Numerical answers should also be accompanied by an appropriate unit, and this was a requirement in **Questions 1(d)**, **3(c)(ii)** and **3(f)**. Appropriate units were also seen in **Table 2.1** and, where necessary, in the results table specified by candidates in **Question 4**.

There will be questions in which candidates are asked to devise approaches to investigations which may or may not be familiar to them or to suggest improvements to methods given in the examination paper. However, these questions can always be answered by careful reading of the question and the logical application of good experimental practice. This was particularly the case for **Question 4**.

In general, many candidates were able to answer all parts of the paper, with very few responses left blank.

Comments on specific questions

Question 1

The graph was understood well but other aspects of the question were challenging for many candidates.

(a) The correct value of distance *d* was determined by many candidates, with the most common error being to give the diameter or radius of the load.

(b) Few candidates were able to outline a satisfactory method for showing that the metre rule was as near as possible to being balanced. Some described moving the ruler backwards and forwards on the pivot but only a small number recognised the technique of achieving a position between the ruler just tilting one way and then just tilting the other way. Most candidates incorrectly described a measurement method for showing whether the ruler was horizontal.

Most candidates calculated the values of *a* and *b* accurately, sometimes as an accepted error carried forward, but many did not record both answers to the nearest mm and could not be awarded full credit.

(c) There were many well-drawn, accurate graphs with clearly labelled axes.

Scale intervals were usually chosen sensibly with very few impractical values. However, many gave a scale for *a* values which occupied less than half of the *y*-axis. Most candidates recognised that the axes should start at the origin.

Plotting was mostly careful and many candidates indicated the plots with fine crosses. Small dots are acceptable but are often obscured when the line is drawn through them, making it more difficult for them to be seen. The large dots or thick crosses used by some candidates are not acceptable as the intended value cannot be determined clearly. A sharp pencil should be used for the plots and for the line so that accurate drawing may be achieved and errors easily corrected.

Many candidates produced a well-judged straight line as indicated by their accurate plots. Only a very small number incorrectly joined points together or diverted the line through the origin when the trend of the plots did not indicate this. Most candidates were able to determine the gradient, showing clearly on the graph that a triangle method had been used. A few triangles were seen which incorporated inaccurate distances on the axes. The most common was a horizontal line to the *y*-axis which went beyond the intercept on the *x*-axis.

(d) There were many values for the mass *M* of the metre rule which fell within the expected range. Where credit was not awarded, it was generally due to omitting the unit of cm or giving an inappropriate unit. Kg was an acceptable unit provided that the value had been recalculated to match.

(e) Only stronger candidates answered this correctly. These candidates referred to the change in the calculated mass of the metre ruler when a piece of clay was added. They either suggested that it was not a suitable change as the mass of the ruler was altered or that it was suitable as the mass of the clay was very small compared to the mass of the ruler. Both responses were acceptable.

Question 2

Many candidates were able to answer this question well, particularly the more straightforward and familiar aspects of the practical.

(a) Most candidates did this well, with a clear parallel connection but there were some careless diagrams with gaps in the circuit. Only a few candidates incorrectly showed a voltmeter in series.

(b) The voltmeter scale was read correctly by most candidates. A small number of candidates gave an incorrect ammeter reading, most frequently by misjudging the scale and recording 0.6 A rather than 0.12 A.

(c) Resistance values were mostly calculated correctly, with only a small number of inaccuracies or rounding errors. A few candidates used the recurring symbol and so could not gain the credit available for consistency of significant figures.

Units of V, A and Ω were usually seen.

Although not encouraged, units expressed in words were accepted. A common error was to indicate the current unit as C, presumably coulombs.

(d) Strong responses were frequently seen but rounding values at an earlier stage in the question produced some incorrect answers here.

The concept of values being able to be considered as equal when they fall within the limits of experimental accuracy was understood by many candidates and the 10 per cent range of those limits was often quoted in responses. However, there were answers which stated that any difference in values suggests that they cannot be considered as equal.

Some candidates did not quote the values from results as required by the question.

(e) Many clear variable resistor symbols were drawn but some candidates did not show the connections included in the standard symbol indicated in the syllabus. Some drew a thermistor or a fixed resistor.

Only a few candidates recognised that a variable resistor made it easier to obtain a range of values or provided the ability to control the current or set it to a required value.

Many candidates ignored the reference to current in the question, mentioning changing resistance rather than current or citing preventing overheating as an advantage.

Question 3

This question was answered well by many candidates, particularly those who were clearly familiar with the experimental procedures.

(a) Many responses referred to the need for the lens and screen to be perpendicular to the bench or for the object and lens to be at the same height. Some candidates incorrectly referred to the lamp rather than the object and a number incorrectly suggested use of a dark room rather than concentrating on the setting up of the apparatus as the question required.

(b) A number of candidates again referred to ensuring that the room was dark rather than focussing on the technique of moving the screen slowly and/or back and forth. Either aspect of this practical technique gained credit. Some candidates incorrectly suggested moving the lens or the object.

Most candidates gained the initial credit available, but some then divided by 10 to give the actual distance as 0.8 cm rather than 80 cm.

(c) Most candidates measured the heights correctly and calculated an accurate value for the magnification. However, a few incorrectly added a unit.

(d) Many candidates gained credit for accuracy with the expected value of 16 cm.

(e) The idea of the student's hand or the ruler obstructing the image was well understood and was a common correct answer, as was the use of a translucent screen to overcome this difficulty. The use of a grid or ruler drawn on the screen was also seen and was an acceptable response.

(f) Most candidates recorded the correct value, but some did not give a unit for this or the previous value of focal length.

(g) Only stronger candidates answered this correctly. These candidates suggested that f_2 might be the more accurate value as f_1 involved the measurement of the much smaller distances of object and image height (with the consequent larger per cent uncertainties). Reference to the fact that V_2 was smaller than V_1, leading to f_1 being the more accurate value, was not credited as it ignored the measurement of the much smaller heights. Many incorrect responses referred to the number of significant figures in the calculated values or to possible poor practice in the techniques.

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A few candidates gained credit by giving a correct procedure for the calculation of cooling rate from measured data.