PHYSICS

Paper 0625/12
Multiple Choice (Core)

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

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

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

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

General comments

When looking at data, candidates need to ensure that they are fully aware of the measurements the data refers to.

Questions 1, **4**, **7**, **15**, **19**, **22** and **38** caused few difficulties showing that candidates had a knowledge of the basic concepts required by the syllabus. Candidates found other questions more challenging, in particular **Questions 3**, **6**, **8**, **11**, **13**, **20**, **29** and **34**.

Comments on specific questions

Question 1

This question was answered well which showed that candidates understood the simple experimental technique and also demonstrated the ability to read quite difficult scales on the measuring cylinders.

Question 3

Some candidates did not seem to be aware that when an object is close to the surface of a planet the acceleration due to gravity is constant. It is only when the object is at a distance of a similar order of magnitude as the diameter of the planet that the gravitational field strength becomes less, and consequently the acceleration is less.

Question 6

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Many candidates found this question challenging. They needed to identify the correct direction that the three forces (weight, drag and upthrust) act in. They also needed to recognise that the resultant force on an object moving at constant velocity is zero.

Question 7

Candidates knew that when work is done against friction that thermal energy is released.

Question 8

Only stronger candidates recognised that the data given in the question gave the markings on the meter rule at which the loads were placed and then used these raw figures directly into the moment equation.

Question 9

Although this question was answered correctly by many candidates, others gave the extension when a load of 2.0 N was applied to the spring. Clearly, they just took the load directly from the third row in the table and did not recognise that the first row indicated that the length of the unloaded spring.

Question 10

The majority of candidates recognised that the gas fired power station produced the most atmospheric pollution per unit of energy generated, but a significant number opted for the nuclear power plant. The actual atmospheric pollution produced by a nuclear power station produces relatively small amounts of such pollution.

Question 11

Most candidates simply multiplied the raw data figures together, not recognising that the distance moved by the point of application of the force was measured in centimetres, rather than the base unit, the metre.

Question 13

Many candidates did not select the correct data to solve the problem and simply multiplied the 3 dimensions of the object together, finding the volume of the object rather than the two dimensions in contact with the surface to give area in contact.

Question 15

This was a well answered question and candidates showed some understanding of kinetic theory.

Question 19

Candidates did well in sorting out the relevant rays and establishing the correct angles.

Question 20

In this question, the powers of ten seemed to confuse some candidates but stronger candidates were able to identify the frequency and wavelength of typical red light.

Question 22

Many candidates showed a good basic knowledge of the types of radiation involved in television signalling.

Question 27

Candidates showed an excellent knowledge of the energy transfers in the circuit and to the atmosphere.

Question 29

Only stronger candidates answered this correctly. Candidates needed to identify the thermistor from the circuit symbol. Then they needed to recognise that the temperature of the thermistor needed to be increased causing a fall in its resistance and an increase in the brightness of the lamp.

Question 34

Candidates found it difficult to establish that the positive ion has lost an electron compared with the neutral atom. Candidates should know that electrons orbit the nucleus, that they are negatively charged and can be removed from the nucleus. Some candidates did not recognise that removing an electron from a neutral atom leaves an ion that is positively charged.

PHYSICS

Paper 0625/22
Multiple Choice (Extended)

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

General comments

When looking at data, candidates need to ensure that they are fully aware of the measurements the data refers to.

Generally, most candidates were able to answer **Questions 2**, **5**, **8**, **10**, **12**, **18** and **21** without any real difficulties showing that candidates had a knowledge of the basic concepts required by the syllabus. Some candidates found **Questions 4**, **6**, **19**, **27**, **31**, **36** and **40** more challenging.

Comments on specific questions

Question 4

In this question, initially the acceleration of the car needed to be calculated (= resultant force divided by mass). Then candidates needed to recognise that the drag force increases and consequently the resultant force decreases as the car goes faster.

Question 6

Candidates needed to identify the correct direction that the three forces (weight, drag and upthrust) act in. They also needed to recognise that the resultant force on an object moving at constant velocity is zero.

Question 18

Most candidates were able to identify the wavelength of the wave on the rope.

Question 19

This question was challenging for many candidates. The strongest candidates were able to work with trigonometrical quantities and managed the fact that the given angle was the complement of the angle of incidence, rather than the angle of incidence itself.

Question 21

Candidates were usually able to trace the path of the light through the prism.

Question 27

Although many candidates were able to identify the changes in resistance of the conductor, others thought that the resistance decreased as the current increased.

Question 31

This question tested the concept that an induced e.m.f. is always in the opposite direction to the change causing it. Stronger candidates had a reasonably good understanding of this, but others found it very challenging.

Question 36

Although some candidates answered this correctly, many thought that keeping 2 m away from colleagues reduced exposure to ionising radiation. There might be other reasons for this rule, (e.g. to limit the exposure to infectious disease), but protection from ionising radiation is not one of them.

Question 40

Although many candidates were able to identify the key, a large number chose option **B**, that the speed was inversely proportional to the distance that the galaxy is from the Earth. Candidates could have used the structure of the question and the given units to help them. The Hubble constant is measured in s^{-1}, speed is in m/s, and distance in m. Thus, for consistency of units, $v H_0 = d$.

PHYSICS

Paper 0625/32
Core Theory

Key Messages

- In calculations, candidates must set out and explain their working correctly. When an incorrect final answer is given with no working shown, it is impossible for partial credit to be awarded for any correct working.
- Candidates should ensure they are clear and precise when answering questions requiring a description or explanation.
- It is important that candidates read the questions carefully in order to understand exactly what is being asked.
- In order to improve their performance, candidates should practise applying their knowledge to new situations by attempting questions in support materials or exam papers from previous sessions.

General Comments

A high proportion of candidates were well prepared for this paper. Equations were generally well known, but some candidates struggled to recall some of the equations. Often candidates had been taught how to apply their knowledge and understanding to fairly standard situations well. On occasion, when asked to apply their knowledge to a new situation, these candidates displayed a lack of breadth of understanding. Stronger candidates were able to think through the possibilities and applied their knowledge when the question asked for suggestions to explain new situations. Weaker candidates did not show the stages in their working and did not think through their answers before writing.

Although some candidates set out their calculations well, there were some who gave two alternative methods. Candidates should be made aware that this is not accepted. Another problem that a minority had was in transposing equations. They regularly started with a correct formula but could not always translate this into correct use of the data in the question.

The questions on determining volume by displacement, density calculation, cost of electrical energy and the time for light to travel from Jupiter to the Earth were generally answered well. The questions on determining load for a given extension, calculating mechanical work done, energy changes in a burning candle, describing the motion of particles in a transverse wave, characteristics of the image in a plane mirror, calculating the current from electrical power and electromagnetic induction were generally not as well answered. There were a significant number of candidates who either did not read the questions carefully, or gave answers that were related to the topic being tested, but did not answer the question in enough detail to receive credit.

There were a very small number of candidates, who struggled to express themselves clearly. Most candidates indicated by their knowledge and skills that they were correctly entered for this Core theory paper. A small minority of candidates found the subject matter and level of some questions more straightforward and would have been better entered for the Extended paper.

Comments on specific questions

Question 1

(a) The vast majority of candidates correctly calculated the average thickness as 1.4 mm. The most common error was to divide 40 by 56 to give an answer of 0.71.

(b) Most candidates gained full credit here.

(c) Most candidates scored at least partial credit with many answering fully correctly. The most common error was giving an incorrect unit.

Question 2

(a) (i) The majority of candidates correctly determined the length of the spring with an 8.0 N load as 20 cm.

(ii) Many candidates found this item challenging. Only stronger candidates realised that an extension of 7 cm gave a spring length of 21 cm.

(b) Many candidates answered this correctly, but almost every other option was chosen by some candidates.

(c) Most candidates correctly calculated the mass as 0.88 kg. The most common error was using an incorrect rearrangement of the equation, e.g. most common error was $m = W \times g$.

Question 3

(a) (i) Many candidates correctly calculated the speed as 25 m / s from the gradient of the line. The most common error was to state that the speed was equal to the area under the line.

(ii) Most candidates identified the cyclist as being stationary. The most common errors were steady movement, steady speed and steady acceleration.

(b) Almost all candidates scored at least partial credit. A common error was to state that increased surface area resulted in better grip on soft ground.

Question 4

(a) (i) The majority of candidates correctly described the movement of gas particles.

(ii) The majority of candidates identified collisions with walls of cylinder as the reason why gas particles exerted a pressure.

(b) The majority of candidates gained at least partial credit but only the strongest linked the reduction in surface area to an increase in the number of collisions per unit area.

Question 5

(a) Most candidates correctly calculated the amount of mechanical work done as 60 J. The most common error was to state that work done = force ÷ distance.

(b) Many candidates found this item challenging. Only stronger candidates recognised that the chemical energy store in the candle decreased and was transferred by light and that the thermal energy store of the surroundings was increased.

Question 6

(a) (i) The majority of candidates identified the amplitude as 2.0 cm. A common error was to give 4.0 cm.

(ii) Many candidates found this item more challenging, with only stronger candidates able to reason from frequency = number of waves sent out per second to give a frequency of 5.0 Hz.

(b) Only the strongest candidates were able to give a correct description of the movement of particles in a transverse wave.

(c) Many candidates correctly calculated the wave speed as 360 m / s. However, a very large number thought that wave speed = frequency ÷ wavelength.

Question 7

(a) The majority of candidates found this question challenging. A common error was to say that the image was the same shape rather than the same size, and to simply state that the image was the same distance, i.e. not stating that the image was the same distance from the mirror as the object.

(b) (i) The majority of candidates gave a valid use of ultraviolet radiation.

(ii) Most candidates gave a valid harmful effect of overexposure to ultraviolet radiation.

Question 8

(a) Many candidates answered fully correctly, but a significant number of candidates incorrectly talked about protons or positive charges moving to the rod.

(b) The majority of candidates answered this correctly.

(c) The majority of candidates recognised that electrons were moving in the metal wire. The most common error was to state protons.

Question 9

(a) (i) Many candidates scored at least partial credit. However, a number did not recall the equation $P = I \times V$ and instead attempted to use $V = I \times R$. Those with the correct method often failed to convert 1.5 kW to 1500 W.

(ii) Many candidates gave an answer of 84 p. However, a significant number of candidates did not recall the equation (cost of energy) = power × time × cost of 1 kW h.

(b) Lack of detail and poorly phrased responses resulted in many candidates not gaining full credit here.

Question 10

(a) The majority of candidates struggled with this item on electromagnetic induction. A common error was to state that when the switch was closed there would be no current in coil P. Candidates should be reminded that when a switch is closed, the circuit is complete.

(b) Many candidates scored at least partial credit here. The most common errors were stating that there were more turns on the primary coil than on the secondary coil, and failing to recall that the core was made from soft iron.

Question 11

(a) The vast majority of candidates identified the proton number as 95 and the number of neutrons as 146. A common error was to state that the number of neutrons was 241.

(b) Candidates found this item challenging. Many identified that there were two half-lives in 860 years, but then divided the 12 mg by 2 or even multiplied the 12 mg by 2.

Question 12

(a) Many candidates found this item difficult. A common error was to state that the third planet from the Sun was either Mars or Neptune.

(b) Many candidates scored partial credit here, but a large number thought that a light year was a unit of time.

(c) Almost all candidates correctly calculated the time as 2600 s. A common error was to use an incorrect rearrangement of the equation speed = distance ÷ time, i.e. speed = distance × time, or speed = time ÷ distance.

PHYSICS

Paper 0625/42
Theory (Extended)

Key messages

Candidates should be reminded to read the questions carefully, to take note of command words and the number of marks allocated to the question. In particular, where a question asks for a definition of a unit or quantity (e.g., **Questions 3(b)(i)** and **7(a)**), this must be precise.

When candidates are required to draw a diagram or draw on a diagram they should use a sharp pencil and a ruler to draw straight lines.

Knowledge should be applied carefully to the specific situation in the question.

General comments

Most candidates were able to carry out complicated calculations and in most cases gave the correct unit with a correct numerical answer.

Where final answers are incorrect, credit may be awarded for any correct working. Therefore, candidates are advised to always show their working in calculation questions.

Candidates should give their answer to two significant figures unless instructed otherwise (e.g., **Question 4(c)**).

In questions requiring a certain number of answers, candidates should be advised not to give more than the required number of answers (e.g. **Question 3(c)**).

Candidates should use the symbols for quantities and the electrical symbols given in the syllabus.

Comments on specific questions

Question 1

(a) Most candidates chose to answer this question by drawing a scale diagram. Stronger candidates drew a careful vector diagram to scale and labelled the directions of the vectors. Most candidates gave a correct answer for speed, either from their scale diagram or with the use of Pythagoras' theorem. Weaker candidates subtracted the two speeds given in the question or used Pythagoras incorrectly. The correct answer for the angle with the river bank was given less often. Common mistakes in angle were giving the angle with the river rather than the river bank and incorrect arrow directions or incorrect diagonal drawn in the scale diagram.

(b) Most candidates correctly stated the name of a vector and a scalar quantity. Credit was not given for the quantities named in the question.

Question 2

(a) Many candidates found it difficult to apply their knowledge of densities and their effect on floating to this specific situation. Stronger answers stated that the ship contained air or was hollow and that meant that the average density of the ship was less than the density of the water. Weaker answers did not compare the density of the ship with the density of the water and the weakest answers stated incorrect statements. Common incorrect statements included that the density of steel is greater than the density of the water, therefore the ship floats or the object with higher density will float on liquid with lower density, and attempts to explain the floating in terms of pressure and the area of the base of the ship or the volume of water was bigger than the volume of the ship.

(b) Stronger candidates clearly stated that the centre of gravity was lowered and that made the ship more stable. The question asked for the effect on stability so the comparative ‘more stable’ was needed. Answers such as “this helps stability” or “this makes the ship stable” were insufficient. Weaker candidates stated that the centre of gravity was fixed and the containers moved towards it when they were near the bottom of the ship or stated that the containers with the greatest mass would crush the other containers if placed on top of them. It should be noted that the correct syllabus term is ‘centre of gravity’ and not ‘centre of mass’.

(c) Weaker candidates sometimes gave the answer with the incorrect power of ten or without a unit. Partial credit was awarded for showing a correct equation.

Question 3

(a) The principle of conservation of energy was well known and accurately stated by many candidates. Weaker answers omitted a reference to both energy created and destroyed or made no mention of energy being transferred. Energy input = energy output was a common incorrect answer.

(b) (i) Few candidates were able to accurately define the unit kWh. There were many incomplete responses that made no reference to it being a unit of energy or did not state that it was the amount of energy being transferred at a rate of 1 kW in an hour. A common incorrect answer was that it was the number of kW per hour.

(ii) This was usually answered well by stronger candidates. The most common error was in an incorrect or no conversion from MW to kW. Some candidates converted hours into seconds. Most candidates correctly stated the equation they were using. Some candidates added the unit J to their answer which was incorrect.

(c) Most candidates were able to identify at least one energy resource not due to radiation from the Sun. Some candidates confused tidal energy with wave energy. Candidates need to be aware that when 2 answers are required, incorrect additional responses will contradict correct responses.

Question 4

(a) Stronger answers carefully described the presence of delocalised electrons in metals, stated that they moved throughout the metal and correctly described the passage of energy by vibrating particles in enough detail. Some candidates could have improved on their answers by clearly stating that the energy was passed to neighbouring particles. There were some incorrect references to electrons vibrating. Some candidates did not read the question carefully enough and referred to transfer of heat by convection or radiation.

(b) (i) This was usually answered well. Stronger answers were concise and referred to the spaces between gas particles and forces, as asked in the question. Weaker answers stated that gases were far apart, implying more than one gas, instead of that gas particles were far apart. Some candidates included irrelevant statements e.g., gas particles being free to move or having random motion or references to pressure instead of forces. There were some contradictions within answers.

(ii) Stronger answers made a clear distinction between evaporation and boiling. Weaker answers were too vague or ambiguous e.g., “boiling occurs faster” or “boiling produces bubbles”. Candidates should avoid the use of the phrase “boiling is a bulk process” as that does not articulate clearly what the process is. A better statement would be “boiling takes place throughout the bulk of the liquid”.

(c) Most candidates were able to identify the correct equation to calculate specific heat capacity and the density equation to calculate mass. Candidates should be advised that symbols used must be those specified in the syllabus and that Q will be ignored if used in place of E (Q is the symbol for charge) and that lower case t will be ignored as the symbol for temperature. Candidates should read the question carefully. In this question, the answer to 3 significant figures was specified so answers to 1, 2 or 4 significant figures were not correct. Weaker candidates used the density as mass or stated an incorrect unit. Most candidates showed their working so, even if they were not awarded full credit, they were able to gain partial credit.

Question 5

(a) (i) Candidates who could correctly recall and rearrange the formula for the critical angle usually gained full credit. Weaker answers were those where the equation was incorrectly rearranged to $c = 1 / \sin n$.

(ii) Stronger answers correctly showed the ray entering the glass block undeviated, undergoing total internal reflection, with angle of incidence = angle of reflection at the straight edge, because the angle of incidence is greater than the value calculated in **(i)** and leaving the block along the normal. Some candidates showed the correct path as the ray entered the block and then showed refraction out of the block at the straight edge or did not make angle of incidence = angle of reflection. The weakest answers showed refraction as the ray entered the block. This question was the most often omitted question on the paper.

(b) (i) This was generally correctly answered. Common mistakes were to omit a unit or to give the answer to only 1 significant figure.

(ii) Stronger answers were exemplified by careful drawing of two correct rays with a sharp pencil and careful use of a ruler so that the image was accurately placed. Most candidates correctly drew one ray through the centre of the lens but weaker candidates went on to draw a ray parallel to the principal axis through a random point to the right of the lens, often resulting in a real image.

(c) Stronger candidates showed rays drawn carefully with a ruler and a sharp pencil, meeting on the retina and with a diverging lens placed to the left of the eye lens. Fewer candidates selected a diverging lens than drew the rays meeting on the retina. Other common mistakes were rays refracting between the eye lens and the retina or rays diverging between the eye lens and retina.

Question 6

(a) Stronger answers clearly referred to particle separation or pressure changes. Weaker answers that were incorrect or insufficient referred to wave or wavefront separation or repeated wording from the question e.g., "particles are compressed".

(b) Most candidates answered this question well, clearly stating that sound needed a medium to travel or that light does not need a medium. Incorrect answers referred to the difference in the speed of sound or light to suggested that sound from the Sun is ultrasound.

(c) This was answered correctly by most candidates. A number of candidates applied ideas about echoes or use of sonar which did not apply in this question. Some were unsuccessful in rearranging the equation for speed in terms of distance and time.

(d) Fully correct answers required the knowledge to convert ms to s and the ability to rearrange the equation relating current to charge and time correctly. Some candidates multiplied the time in ms by 1000 to get time in s or more often divided by 1000 or by 60. Most candidates knew which equation to use. The use of the symbol C is not an acceptable alternative to Q for charge.

Question 7

(a) This question asked for a definition of potential difference (p.d.) so a precise answer was required. The most common mistakes were to refer to the whole circuit, confusing the definition with that of electromotive force (e.m.f), or to omit to state that it was the energy per unit charge. Weaker candidates stated "it is the voltage".

(b) (i) The equation for e.m.f is an addition to the syllabus and was not well known. Symbols of C for Q and V for E were not acceptable. Some candidates only wrote down the right-hand side of the equation. Another common incorrect answer was $V = IR$ or $E = VIt$

(ii) Many candidates could correctly apply the equation that they were unable to apply in symbols in **(i)**. Incorrect answers included use of $P = VI$ or Work done = Fd or an incorrect unit of W.

(c) (i) Most candidates correctly placed components in series. The circuit symbols for a d.c. power supply and a thermistor were often not correct. Candidates need to know the electrical symbols given in the syllabus including knowing the difference between symbols for a cell, a battery, a d.c. power supply, an a.c. power supply and an unspecified power supply.

(ii) Stronger answers stated that the resistance (of the thermistor) decreased (as temperature increased) and then either stated that the current increased or the p.d. across the thermistor increased or the p.d. across the bulb increased or the resistance of the circuit decreased. Weaker answers did not specify which component they were referring to when referring to p.d. A reference to the bulb being brighter was not sufficient for credit as the question asked for an explanation of what happens in the circuit. It should be noted that only NTC thermistors are required by the syllabus so no credit could be given for an answer stating that the resistance (of the thermistor) increased.

Question 8

(a) The correct answer was downwards or into the page. Answers such as "left to right" or "from North to South" were insufficient. An incorrect answer was obtained by candidates who used the right-hand rule to determine the direction.

(b) Stronger candidate correctly stated that the current, (magnetic) field and direction of motion or force were all perpendicular or made reference to the left-hand rule and also described how they used the left-hand rule in this specific situation or correctly stated both the direction of the current and the direction of the field. Weaker answers only made reference to the left-hand rule or that current, field and motion were perpendicular to each other.

(c) Some candidates were awarded credit for stating that the coil stops (as it reaches the vertical position). Other answers suggested that the coil would return to its original horizontal position. Few candidates made reference to a change in the turning effect for their explanation, and a reference to a change in force was insufficient. Candidates could only be awarded credit if they realised that the situation was that of a motor and not a generator. References to no field lines being cut, inertia of the coil, continuous motion, reversal of motion or induced e.m.f. were all irrelevant to this question,

(d) Stronger candidates made reference to the direction of the current being reversed and this occurring every half turn, the coil continuing to move in the same direction or the current being maintained. Some weaker answers suggested that the split ring commutator was transferring the current from the coil to the circuit, again confusing motors and generators.

Question 9

(a) (i) Stronger answers referred to the splitting of unstable nuclei by neutrons resulting in a large energy release. It was important that the reference was to nuclei splitting and not atoms, isotopes or elements splitting. Some candidates confused fission with fusion but could be awarded partial credit if they referred to energy being released.

(ii) Stronger answers gave detail, e.g., that nuclear energy is available all the time as an advantage and that nuclear power stations are expensive to build or decommission or hazardous radioactive waste is produced or is difficult to store. Vague answers of them being more reliable or expensive or producing waste were insufficient for credit.

(b) Candidates were usually able to transfer the information in the question to show the correct nuclides of deuterium on the left-hand side. Many found it more difficult to construct the right-hand side of the equation, often giving a helium isotope with 4 nucleons and/or omitting the nuclide notation for a neutron. Care was needed to include correct symbols and N (the chemical symbol for nitrogen) or neutron in words were not acceptable for n.

Question 10

(a) Many candidates answered this question well, using the correct equation and converting time in days into seconds correctly. Common mistakes were using the radius instead of the circumference for the distance, converting the time into hours instead of days, other mistakes in the conversion of time into seconds or giving the wrong unit or omitting the unit. Most candidates showed their working. Candidates should read the question carefully. This question asked for the speed in km / s. The speed in other units could not be awarded full credit.

(b) The syllabus clearly states that the planets have elliptical orbits. Approximately circular was an acceptable answer but circular alone was insufficient and two responses with one incorrect e.g., elliptical/circular were not awarded credit.

(c) (i) Stronger answers clearly stated that the wavelength of light or electromagnetic radiation from a distant galaxy increased due to the galaxy receding (from Earth). Less precise wording referring to the wavelength of the galaxy or an object or vague statements about objects moving away were incorrect or insufficient.

(ii) This question required the answer of speed (that galaxy is moving away from the Earth) as this is the quantity that can be directly calculated from the amount of redshift. Common incorrect answers included Hubble constant, light years, distance, wavelength, age of Universe.

PHYSICS

Paper 0625/52
Practical Test

Key Messages

- Candidates need to have had a thorough grounding in practical work during the course, including reflection and discussion on the precautions taken to improve reliability.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. These techniques will be tested at some point in the paper.
- Candidates should be ready to apply their practical knowledge to designing an investigation. Planning questions can be answered by developing solutions from standard experimental techniques.
- It is important that Centres provide a full set of Supervisor's Results where required and that any variation in equipment from that specified in the Confidential Instructions is clearly indicated.

General comments

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

- 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 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 had regular experience of similar practical work.

There will be questions in which candidates are asked to devise approaches to investigations which may or may not be familiar to them. However, candidates will be able to answer these questions with careful reading of the brief and the logical application of good experimental practice.

Comments on specific questions

Question 1

(a) (i) Most candidates obtained a sensible value for *D* and expressed the value to the nearest mm. However, a number rounded to the nearest cm. An average diameter was calculated correctly by most candidates.

(ii) Only stronger candidates expressed the idea that the effect of the uncertainty in the measurement is reduced by measuring a number of marbles. A few gained credit by realising that the diameters of the individual marbles might vary.

(b) Most candidates drew a clear diagram showing the marble between the two blocks with the gap between the blocks being measured. However, some did not say which distance should be measured. Only stronger candidates gained credit for recording d_2 and stating a suitable means of ensuring accuracy. Stronger candidates suggested that the gap should be measured in two places to ensure that the blocks were parallel or that the marble should be rotated, and the diameter measured on a different axis with the average being taken.

(c) (i) This was answered well by most candidates, with a suitable value for *m* recorded to one decimal place.

(ii) Most candidates gave suitable values for the volumes and calculated *V* correctly.

(iii) Many candidates showed an arrow, perpendicular to the scale and indicating the lower meniscus. A common error was either omitting the arrow or indicating another point on the meniscus rather than the arrow not being perpendicular.

(iv) The calculation was generally correct, with many candidates obtaining a value of ρ in the expected range and expressing this to 2 or 3 significant figures.

(d) Most candidates offered an unacceptable source of inaccuracy which was to do with poor practice rather than an inherent issue with the equipment or procedure. Very few candidates pointed out that the measuring cylinder might only measure to the nearest cm^3 and that an improvement could be made by using a cylinder with a more accurate scale.

Question 2

(a) Most candidates obtained a clear, continuous fall in temperature in the beaker. Only a very small number recorded the room temperature as θ_0 or did not wait for the temperature to reach a maximum value before starting the timing.

(b) This was often answered well. The most common error was to use a starting temperature similar to the first experiment, rather than waiting until the temperature fell to the same as θ_{90} in the first experiment and so not obtaining a comparatively slower rate of decrease in temperature.

(c) Good conclusions were often seen, making the connection between a higher starting temperature and a greater rate of cooling. Some candidates did not give values for the comparative temperature changes over 180s and so could not gain full credit.

(d) (i) (ii) Many correctly calculated cooling rates were seen, with the appropriate unit of °C / s. Occasionally the unit was omitted. Many candidates obtained cooling rates which were within 10 per cent of each other as expected.

(d) (iii) Most candidates were able to make a correct statement based on their values of cooling rate, with only a very few disagreeing with the suggestion because the values were not exactly the same. Many candidates recognised that the values for the two cooling rates were within the limits of experimental accuracy, and some gave their values in support of this or calculated the percentage difference to show that they were within 10 per cent of each other.

(e) Many candidates were able to suggest a suitable variable to be controlled, usually including the volume of water, reference to the thickness or surface area of the beaker or a suitable environmental condition such as room temperature.

Question 3

(a) Much good practical skill was shown with many candidates obtaining good readings and recording them well. The appropriate ranges and patterns of change in *V* and *I* were often seen.

(b) Accurate calculation was generally seen with good attention paid to correct rounding. However, some sets of *R* values were expressed to an inconsistent number of significant figures.

(c) There were many well-drawn, accurate graphs with clearly labelled axes. Scales were usually chosen sensibly. Only a few candidates used impractical scales which often made it difficult for them to determine positions for plotted points. Plotting was generally careful with most candidates indicating the plots clearly with fine crosses. Small dots were acceptable, but candidates needed to ensure they were not obscured when the line was drawn through them. The large dots used by some candidates sometimes meant that the intended values could not be determined clearly. A sharp pencil should be used for the plots and 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. Some drew a thick line by joining points together or by trying to force the line through the origin when it was not suggested by their plots. This latter approach could be within the expected range and was credited provided that the trend of the other points was taken into account.

(d) (i) A gradient was most often determined with a clear indication on the graph of how this was achieved. The most straightforward method was the use of a large, clear triangle drawn on the straight graph line.

(ii) Credit was awarded for the overall quality of technique in the response. It was given for a value reflecting the gradient and which was in an expected range. A small number of candidates gave a value which did not match the gradient, suggesting that these candidates had not read the question properly.

(e) Only stronger candidates answered this correctly. Many incorrect responses referred to poor practice, such as not reading the meters accurately or attaching the crocodile clip to the wrong length, ignoring the instruction in the question to "assume that the procedure has been done carefully". Stronger candidates indicated that the point of contact between a wire and a crocodile clip is unpredictable and that it is very difficult to judge the length of resistance wire being tested because of this. Reference to the possibility of the resistance wire not being uniform was also acceptable as an answer.

Question 4

Stronger candidates 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.

A selection of balls was included in the available apparatus to give candidates the opportunity to indicate that only balls of the same mass/diameter should be used during the experiment. Use of the same ball throughout was also credited. Many candidates did not read the information correctly and planned an experiment which investigated how the range was affected by changing the mass or diameter of the ball.

It is often the case that experiments are repeated by changing another variable, such as the mass of the ball in this case, to test if the patterns obtained still apply under other conditions. However, candidates must avoid confusing these variations with changes in the required independent variable. They are best referred to only when the requested investigation has been fully described.

Many candidates were able to identify the need for a metre rule/tape measure and a protractor to measure the variables of range and angle. A protractor was the apparatus most often omitted by others.

It was important to describe the steps of the experiment, including measuring/setting the angle of launch of the ball. Measuring of the range was also an essential step.

Some candidates incorrectly suggested measuring the distance to the position that the ball reached when it had stopped rolling, rather than to the point at which it landed after leaving the channel.

Many candidates were able to clearly state that the procedure should be repeated with a different value of independent variable (angle or height of the lower end of the channel) rather than this just being implied.

Most candidates stated at least one key variable which should be kept constant. For many this was use of the same (mass/diameter) ball or the same starting point on the channel for launching the ball.

Many well-thought-out tables were seen, containing clear columns for readings of independent and dependent variables, with appropriate units. The most common error was the omission of units.

A comment on the analysis of results was expected. The most straightforward responses suggested that if a change in the independent variable produced a change in the measured dependent variable, this showed that the angle of launch affected the range of the ball.

Mention of a graph, with suitable axes clearly stated, was sufficient to gain credit for analysis. Candidates should recognise that the use of a bar chart is not appropriate for a continuous variable such as angle.

Many candidates also suggested a means of ensuring a reliable experiment. Some of the most common responses suggested taking at least five sets of data in order to plot a reliable graph or mentioned the use of a sand tray to identify where the ball landed. Repeating each measurement of the dependent variable and obtaining an average value was also suggested. The vague statement “repeat the experiment” insufficient for credit here.

PHYSICS

Paper 0625/62
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 precautions taken to improve reliability.
- Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. These aspects of recording will be tested at some point in the paper.
- Candidates should be ready to apply their practical knowledge to designing an investigation. Planning questions can be answered by developing solutions from standard experimental techniques.
- Candidates should learn to pace themselves carefully throughout the paper so that adequate time may be given to each question.

General comments

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

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

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. 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 doing experiments. However, there are parts of this examination in which the candidates are asked to answer from their own practical experience. Questions on experimental techniques were answered much more effectively by candidates who showed evidence of having had regular experience of similar practical work.

There will be questions in which candidates will be asked to devise approaches to investigations which may or may not be familiar to them. However, candidates will be able to answer these questions with careful reading of the brief and the logical application of good experimental practice.

Most candidates had enough time to complete the paper, but a small number appeared to rush the end of **Question 4** and were not able to adequately express how to record the results or use them to reach a conclusion.

Comments on specific questions

Question 1

(a) (i) Most candidates measured *D* correctly and expressed the value to the nearest mm. However, some candidates rounded up to the wrong value of mm or rounded to the nearest cm. An average diameter was calculated correctly by most candidates and was accepted even if the *D* value was incorrect.

(ii) Only stronger candidates expressed the idea that the effect of the uncertainty in the measurement is reduced by measuring a number of marbles. A few gained credit by realising that the diameters of the individual marbles might vary.

(b) Most candidates drew a clear diagram showing the marble between the two blocks with the gap between the blocks being measured. However, some did not say which distance should be measured. Only stronger candidates gained further credit for accuracy by suggesting that the gap should be measured in two places to ensure that the blocks were parallel or that the marble should be rotated, and the diameter measured on a different axis, with the average being taken.

(c) (i) This was well answered by most candidates. However, some candidates added a second, unnecessary, decimal place.

(ii) Most candidates read correctly from the bottom of the meniscus with only a small number reading from the upper value or expressing the reading as 30.8 rather than 38 cm^3.

(iii) (iv) The calculations were generally correct, with many candidates obtaining the expected value of ρ.

(d) Most candidates offered an unacceptable source of inaccuracy which was to do with poor practice rather than an inherent issue with the equipment or procedure. Very few candidates pointed out that the measuring cylinder only measured to the nearest cm^3 and that an improvement could be made by using a cylinder with a more accurate scale.

Question 2

(a) (i) The room temperature was given correctly in the vast majority of responses, but there were some responses of 20.1 rather than 21 °C.

(ii) Perpendicular viewing of the temperature scale (the only acceptable response) was often correctly mentioned but was sometimes negated by references to waiting for the temperature to stop rising or ensuring that the thermometer was not touching the side of the beaker. Candidates should consider the situation described rather than quoting from a learned set of techniques.

(b) This was often answered well. The most common error was to enter the same starting temperature as the first experiment.

(c) Most candidates answered well, making the connection between a higher starting temperature and a greater rate of cooling. However, some did not give values for the comparative temperature changes over 180s and so could not gain full credit.

(d) (i) (ii) Many correctly calculated cooling rates were seen, with the appropriate unit of °C / s. Occasionally the unit was omitted.

(d) (iii) Most candidates were able to make a correct statement based on their values of cooling rate, with only a very few disagreeing with the suggestion because the values were not exactly the same. Many candidates recognised that the values for the two cooling rates were within the limits of experimental accuracy and gave the values in support of this. Some calculated the percentage difference to show that they were within 10 per cent of each other but others did not show the values at all.

(e) Many candidates were able to suggest suitable variables to be controlled, generally including the volume of water, reference to the thickness or surface area of the beaker or a suitable environmental condition such as room temperature.

Question 3

(a) Most acceptable answers showed a correctly represented voltmeter connected to the left-hand end of the resistance wire and the lower part of the crocodile clip, often coinciding with the dotted line.

Very few candidates showed the more usual arrangement of the voltmeter connected in parallel in the main part of the circuit.

(b) (i) Most candidates were able to interpret the meter readings, with only the occasional representation of the current as 0.83A.

(ii) Most candidates calculated the resistance correctly, with the number of significant figures matching other values in the column. However, some candidates showed three significant figures rather than an incorrect value.

(c) There were many well-drawn, accurate graphs with clearly labelled axes. Scales were usually chosen sensibly. Only a few candidates used impractical scales which often made it difficult for them to determine positions for plotted points. Plotting was generally careful with most candidates indicating the plots clearly with fine crosses. Small dots were acceptable, but candidates needed to ensure they were not obscured when the line was drawn through them. The large dots used by some candidates sometimes meant that the intended values could not be determined clearly. A sharp pencil should be used for the plots and the line so that accurate drawing may be achieved, and errors easily corrected.

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