PHYSICS

Paper 0972/11
Multiple Choice (Core)

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

General comments

In numerical questions, it was clear that some candidates had used trial and error to find a combination of the data that would produce one of the answers regardless of the logic or otherwise of such a combination.

Comments on specific questions

Question 1

A number of weaker candidates thought that mass could be determined by lowering an irregular object into a measuring cylinder half-full of water.

Question 2

Most candidates thought that the heavier stone would reach the floor first.

Question 3

Only stronger candidates answered this question well, with other responses evenly spread over the options. Candidates had to translate minutes into hours and to recognise that average speed is total distance divided by total time.

Question 4

Only stronger candidates had a secure understanding of the conservation of mass.

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Question 6

Weaker candidates did not subtract the mass of the empty flask in order to find the mass of the liquid.

Question 10

While stronger candidates answered correctly, a large number of other candidates believed that shining a light onto a block of iron does not transfer energy. For that to be true, the block would have to be reflecting the light perfectly, which is impossible.

Question 11

Weaker candidates did not realise that for the box to gain energy, work must be done on it, and that for work to be done, movement in the direction of the applied force is needed.

Question 12

To answer this question, candidates needed to know the formula for pressure and to be careful about unit conversions.

Question 13

The most popular option was **C**, indicating that many candidates did not know that there is a vacuum above the mercury.

Question 17

Only stronger candidates identified mass as the non-thermometric property. Other candidates were unable to demonstrate a secure knowledge of this area.

Question 18

Many candidates were able to spot the connection between a greater thermal capacity and a greater quantity of energy being needed, but then some confused thermal capacity with latent heat.

Question 19

Many candidates correctly identified that a longer strip of wax would melt but only the strongest of these were able to extend that idea to the earlier dropping of the pin.

Question 21

Only stronger candidates identified this wave as longitudinal.

Question 22

This question was usually answered well. The most common error was to confuse refraction and diffraction.

Question 23

Many candidates found this question challenging. At angles *infinitesimally* larger than θ, no light will emerge, so this is indeed the critical angle. And since the question declares that there is *some* light not travelling along the reflection path, it cannot be *total* internal reflection.

Question 26

While stronger candidates answered correctly, many weaker candidates chose option **B**.

Question 27

As many candidates selected option **A** as the correct option, **B**.

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Question 29

The most popular response was **A**, possibly because candidates did not read the question carefully enough and were expecting negatively charged rods.

Question 30

While some candidates successfully added the two resistances, many then divided the total resistance by the potential difference rather than the other way round.

Question 33

This question proved challenging for many candidates and only the strongest had a secure concept of the role of a fuse to protect the cables between it and the appliance from overheating.

Question 36

A significant number of weaker candidates thought that one or other of the suggestions would have no effect.

Question 40

A significant number of weaker candidates thought that the half-life was half of the maximum time shown on the horizontal axis.

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PHYSICS

Paper 0972/21
Multiple Choice (Extended)

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

General comments

Many of the questions were answered correctly by the majority of candidates.

Comments on specific questions

Question 3

A significant number of candidates incorrectly chose option **D**. This was probably based on it being the lightest of the balls.

Question 7

The most popular option was **A**, implying that candidates had multiplied force by mass to obtain the resultant force, and had then not performed the necessary subtraction.

Question 8

A majority of candidates subtracted the two velocities without taking into account the fact that the final velocity is of the opposite sign to the initial velocity. So they obtained a velocity change of 2 m / s instead of 4 m / s.

Question 10

A significant number of candidates believed that shining a light onto a block of iron does not transfer energy. For that to be true, the block would have to be reflecting the light perfectly, which is impossible.

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Question 11

A significant number of candidates did not notice that the time needed converting to seconds.

Question 12

Although stronger candidates answered this question correctly, many others did not. Candidates needed to know the formula for pressure, and to be careful about the conversion of units.

Question 13

Many candidates thought that the pressure in the Torricellian vacuum is above atmospheric pressure but stronger candidates answered correctly.

Question 19

A large number of candidates did not recognise that atomic vibrations transfer energy to the free electrons and receive it at the destination.

Question 20

Option **A** was a common incorrect choice, probably because candidates recognised than black surfaces are better emitters than white surfaces. This was in spite of the fact that the question stated that the black surface is emitting less radiation in this case and that conductors of radiation makes no sense in this context.

Question 21

Although stronger candidates answered this correctly, a number of other candidates selected option **A**.

Question 22

A significant number of candidates forgot to take the sines of the angles.

Question 23

Only stronger candidates answered this correctly. At angles *infinitesimally* larger than θ, no light will emerge, so this is indeed the critical angle. And since the question declares that there is *some* light not travelling along the reflection path, it cannot be *total* internal reflection.

Question 25

Stronger candidates answered correctly. However, a large number of other candidates did not notice the 'there-and-back' nature of the situation, and others did not convert from km to m.

Question 27

Candidates were not expected to know any of the relative velocities, but they should know that sound travels considerably faster in solids than in gases or liquids.

Question 28

Nearly as many candidates selected option **A** as the correct option, **B**.

Question 30

There was a common belief that positive ions can move around in a metal. It is just the electrons that do the moving.

Question 32

Many candidates found this question challenging. When the resistance of the LDR is low, the p.d. across it is low and vice versa, so that eliminates **A** and **B**. Candidates then needed to be clear that, in dim lighting, the LDR's resistance is high.

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Question 33

Only the strongest candidates answered this correctly. The right-most gate is a NAND, so it will give 0 when 1's are present on both of its inputs, but a 1 otherwise. The two left-most gates are operating as inverters, so the overall output will be 0 when both inputs are 0's and 1 otherwise. This is the behaviour expected from an OR gate.

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PHYSICS

Paper 0972/31
Theory (Core)

Key messages

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

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

General comments

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

Candidates should be careful to use precise language as many frequently stated a property had changed but failed to state how it had changed i.e. increased/decreased.

Almost all candidates attempted all of the items and appeared to have no difficulty in completing the paper in the time allowed.

Comments on specific questions

Question 1

(a) (i) A large majority of candidates recognised that the graph shows constant speed. The most common errors were to state either "constant" or "constant motion" which could not be credited. A very small number of candidates answered that the car was stationary.

(ii) Almost all candidates stated that the graph showed (constant) deceleration or that the car was slowing. A small number answered incorrectly that the car has decreasing acceleration.

(iii) The majority of candidates correctly calculated the distance travelled as the area under the speed-time graph between 50 s and 90 s as 120 m. Candidates showed good understanding that distance travelled is the area under the graph and knew how to find this. The most common errors involved forgetting to halve and so giving 240 m as the answer or involved powers of 10, for instance using a time of 4 s rather than 40 s.

(b) (i) This question was answered well by almost all candidates. Weaker candidates inverted the equation and so divided the time by the distance.

(ii) Most candidates drew a horizontal line that stretched for an appropriate time at the appropriate part of the graph. Common errors included drawing a line as a continuation of the 6 m / s line or one that was too short or at the wrong speed. Some candidates ignored the instruction to draw the line on the existing axes and wasted time drawing their own axes. If the drawing was accurate these answers were credited.

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Question 2

(a) (i) The majority of candidates calculated the correct answer of 0.12 (N). The most common error involved not converting to kilograms, which led to an answer of 120 (N). A less common error was to divide by *g* rather than multiply by it. This was incorrect science and so was not credited.

(ii) The majority of candidates calculated the correct answer of 14 g / cm^3. Weaker candidates inverted the equation and so divided the volume by the mass or simply multiplied the two values.

(b) (i) (ii) The correct boxes were ticked by the majority of candidates. The most common error in **(ii)** was to indicate that density increases rather than decreases.

Question 3

(a) The vast majority of candidates calculated the correct moment. The most common errors were to multiply 404 by 1.6 or 404 × (1.2 + 1.6) or to divide the force by distance.

(b) Again, most candidates correctly equated moments and calculated the force to be about 300 (N). The most common error was to either divide 404 by 1.6 or to multiply 404 by 1.6.

Question 4

(a) Stronger candidates gave their answer in a well-ordered sequence, stating that the coal is burnt to heat water which becomes steam which drives a turbine, causing a generator to turn giving electricity. There were many candidates who answered in such a way. Weaker candidates often missed out one or two stages or compressed separate stages into one process. It was not unusual to see that the coal was burnt and the gases from it drive the turbine, or that the turbine was turned which produced electricity, or that water in the coal was heated, or that the heated coal drove a generator.

(b) Many candidates found this item challenging. Stronger candidates stated that it meant that only a small fraction of the input energy became useful output energy or that large amounts of energy were wasted, showed good understanding of the concept. Weaker candidates clearly knew what efficiency meant but missed out the need for the fact that <u>much</u> energy is wasted. The weakest candidates gave answers such as “it does not work very well” or “it is renewable” and clearly did not understand the scientific meaning of efficiency.

(c) This was answered well by the majority of candidates, with most candidates gaining at least partial credit. The most common creditworthy answers were “non-renewable”, “contributes to global warming/production of carbon dioxide” and “acid rain”. Weaker candidates simply stated “pollution” or “harms the environment” and these were not considered precise enough for credit.

Question 5

(a) (i) The vast majority of candidates gained full credit. Common errors included giving 32 or 240 for the force and a very small number of candidates stated “east” without indicating which direction they thought was east.

(ii) The majority of candidates answered this correctly, giving two equal values of the force. A common error was to put two zeroes.

(b) This was another question that was very well answered and most candidates gained full credit by calculating the pressure as 125 (N / cm^2). A common error was to forget that the suitcase had two wheels and so these candidates gave 250 (N / cm^2) as the answer. Weaker candidates multiplied the force by the area.

Question 6

(a) Most candidates knew that the motion was Brownian motion. Most of those who did not give the name realised that the motion was random. The most common error was to state that the term used was diffusion.

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(b) Stronger candidates realised that the haphazard motion of the pollen grains was a result of (invisible) air molecules bombarding the pollen grains. Weaker candidates thought that the motion was a result of pollen grains colliding with other pollen grains.

Question 7

(a) This item was usually answered correctly and full credit was frequently awarded. Common errors included giving white, black and pink in their list of colours (or giving both purple and violet) and so not giving the six correct colours that were required. The majority of candidates put the colours in the correct order but a small minority reversed the order and a few gave the colours in no particular order.

(b)(i)(ii) A large majority of candidates gave refraction and dispersion in the correct order. A common error was to give them in the reverse order. Other errors included giving reflection or rarefaction for refraction. Some candidates gave diffraction, spreading, spectrum, colours for dispersion.

(c) The majority of candidates gave at least one of these correctly but there was a considerable amount of confusion about the electromagnetic waves used in tv remote controllers.

Question 8

(a) (i) Most candidates answered this correctly. The most common errors were frequency and wavelength.

(ii) Fewer candidates gained credit for this question. The most common error was wavelength.

(b) (i) Some candidates found this item challenging. Most gave the correct answer of 160 m. The most common error was 80 but a few candidates attempted to calculate the speed here and gave their answer as the distance.

(ii) Most candidates who did not give 285.7 gave 142.8 as their answer (sometimes because of the incorrect use of 80 m as the distance, sometimes as an error carried forward from an incorrect distance in **(i)**). A very small number multiplied a distance by 0.56 showing a fundamental misunderstanding.

(iii) Many candidates gave valid suggestions for improvement of the experiment. Most who gained credit suggested standing further from the wall, both standing the same distance from the wall or repeating and taking an average. A common mistake was not stating the essential need to average the repeated results.

Question 9

(a) (i) The majority of candidates correctly gave plastic and wood as their answer. The most common errors were giving only one of them or adding aluminium and/or iron.

(ii) The vast majority of candidates correctly gave iron as their answer with only a few adding aluminium to the list.

(b) The vast majority of candidates correctly identified all three poles. A few reversed the poles on the right-hand magnet and a very small number used P instead of S.

(c) The majority of candidates correctly stated that the electromagnet can be switched off and/or on or could be magnetised/demagnetised easily. Common answers that did not score included “that it could be magnetised”, “that it was strong(er)”.

(d) Most candidates correctly identified the property giving the strongest electromagnet in each column. The most common error was to choose 20 mA instead of 3.0 A in the third column.

Question 10

(a)(i)(ii) The vast majority of candidates correctly evaluated the combined resistance in **(i)** and slightly fewer evaluated the current in ammeter Y in **(ii)**.

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(b) Most candidates gained partial credit for stating that the current in ammeter X would increase. Only a minority stated that the resistance decreases and the current increases. Only stronger candidates scored full credit.

(c) This was often answered well with a correct evaluation giving the resistance of the lamp as 15 (Ω). Weaker candidates inverted the equation and so divided the current by the voltage or simply multiplied the two values.

Question 11

(a) The majority of candidates correctly identified the type of voltage in the coil as alternating.

(b) The majority of candidates correctly identified two ways of increasing the induced voltage. The most common correct answers included “increase turns”, “use a stronger magnet” or “increase speed of magnet”. The most common error was to suggest increasing the current.

Question 12

(a) (i) The majority of candidates correctly identified the two uranium isotopes. The most common error was to state Pu-238 and U-238.

(ii) The majority of candidates correctly identified Pu-238 and U-238. The most common error was to state Pu-238 and Th-34. This was probably due to confusion between nucleon number and neutron number.

(iii) The majority of candidates correctly identified Pu-238. The most common error was to state U-238.

(b) The majority of candidates correctly worked out that there are 3 half-lives and many of these used the 3 to work out the correct answer of 5.0 mg. The most common errors were to multiply 40 by 3 or to divide 40 by 3. A few considered only 2 half-lives to get the answer 10 mg.

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PHYSICS

Paper 0972/41
Theory (Extended)

Key messages

- Candidates should ensure they take note of the command word used and answer the question to provide the information required.
- Candidates are reminded to consider the number of marks available for each question as well as the space available for their answer. This should be used as a guide but should not dictate the length of a response. Where a number of lines are given for a response, a one-word answer is unlikely to be sufficient.

General comments

Candidates need to be conversant with the whole extended syllabus in preparation for this paper and many stronger candidates were. To be sure of producing answers that are accurate and detailed, candidates need to have understood all that is included in the syllabus.

Some candidates demonstrated errors which were due to the misuse of a calculator. Candidates need to be familiar with their own calculator and, in particular, how to enter a number in standard form. A common source of inaccuracy was to enter a number that was ten times larger than the number given in a question in standard form.

Comments on specific questions

Question 1

(a) (i) Most candidates understood what was meant by the term acceleration and how it can be calculated from a graph. The single most significant source of inaccuracy was to calculate a value for an average deceleration for either the first 3.0 s or the entire 6.0 s rather than for the deceleration immediately after opening the parachute. This often produced an answer that was not within the acceptable range.

(ii) Many candidates used the deceleration obtained in **(i)** to calculate the resultant force acting on the parachutist but only a very small minority realised that the air resistance also had to oppose the weight of the parachutist. Full credit was rarely awarded although partial credit was quite commonly obtained.

(b) Many candidates stated that the parachutist ultimately reaches terminal velocity when the resultant force becomes equal to zero but fewer candidates made one of the other two points that relate to the forces acting before terminal velocity is reached. A small number of candidates supplied explanations that would explain how a parachutist who starts with zero velocity downwards accelerates until a terminal velocity is reached before opening the parachute.

(c) Stronger candidates made relevant points, but very few answered the question as it had been set. More candidates repeated points that had already been made in **(b)**.

Question 2

(a) (i) Many answers related to the momentum change experienced by the trolley and the correct answer was often given. A common error was the use of the mass of the ball rather than that of the trolley and candidates who tried to use the combined mass of the ball and trolley did not always convert the mass of the ball in grams to a mass in kilograms correctly. The unit given for impulse was

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sometimes inaccurate. In addition to the acceptable units, kg / m / s, kg m / s^{-1} and N / s were sometimes given.

(ii) Although the final answer was often given correctly, the use of either the mass of the trolley or a mass in units that did not match those of the number in the answer often led to incorrect answers.

(b) Many candidates obtained credit for an accurate description of the energy transfer that occurs as the trolley slows. However, fewer candidates were able to describe what was happening in terms of work done. Some candidates simply omitted any reference to work done whilst others just defined work done and made no further reference to it in the response.

Question 3

(a) Many candidates referred to the small intermolecular distances in liquids and others to the strength of the repulsive forces. For full credit, both points needed to be made. The attractive forces are not important when the difficulty of compressing liquids is being explained and some answers that would otherwise have been completely correct were incomplete by referring only to attractive forces.

(b) (i) Credit was often awarded for the use of the equation $P = F / A$ and for a calculation leading to 5.5×10^5 (Pa) but only a few candidates went on to add on the pressure of the air. Many candidates ignored it and others subtracted it.

(ii) Many candidates stated that the increase in depth leads to an increase in pressure in the oil and some candidates quoted the relevant expression $P = h\rho g$. Fewer candidates then explained that the pump needs to exert an increasing pressure on the oil in order to overcome this increase in pressure.

(iii) The statement that these two forces are equal was not enough for any credit. It needed to be clear that the forces cancelled or that there is no resultant force. Very few candidates made any reference to the weight of the piston or to friction within the mechanism.

Question 4

(a) There were two approaches here. Candidates could simply compare the thermal conduction properties of aluminium and plastic or could explain why, in terms of the use of a saucepan, such properties are an advantage. A very large number of candidates were awarded credit for this part. However, some candidates only referred to the plastic or the handle.

(b) (i) Many candidates were able to state that the increase in internal energy corresponded to an increase in either the kinetic or potential energy of the molecules.

(ii) The question indicated that both the atomic lattice and the electrons need to be referred to in the answer. Many answers referred only to electrons or less commonly only to the lattice. Some candidates described the mechanism by which the atomic lattice transfers thermal energy but substituted the word electron for atom or molecule. This was not awarded credit.

(iii) An approach that was frequently observed in this part was to give an explanation that would have been more appropriate for explaining evaporation or to describe the increase in temperature that takes place before the boiling point is reached. Few candidates made any mention of the increase in the potential energy of the molecules that occurs as they leave the boiling water.

(iv) There were many good answers here and full credit was often awarded. The equation that defines specific heat capacity was often quoted but it was not always used. When it was quoted as $Q = mct$, some candidates substituted the time of 300 s for t. Candidates should be encouraged to use the symbols that appear in the syllabus where t is used for time and T for temperature.

Question 5

(a) There were many answers here that showed some understanding of the thermal expansion of a liquid and partial credit was often awarded. There were also answers that seemed to describe the change in volume that takes place when a liquid becomes a gas. Answers that referred to the

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expansion of individual molecules were not awarded full credit but, in some cases, credit was awarded for other comments made.

(b) Only stronger candidates answered this question well. Some candidates offered partial explanations in terms of the intermolecular forces but a less successful approach was based on the larger intermolecular spacings in liquids.

(c) (i)(ii) Few answers suggested that either sensitivity or range were quantities that were understood. Some candidates suggested that the sensitivity of a thermometer referred to the speed with which it reached the final temperature reading and the most common answer to **(ii)** was that the range of both thermometers and the diameter of the tubes would be equal.

(d) (i) This question required reference to a problem and this was very commonly not stated. When the example chosen was the thermal expansion of railway tracks it was necessary to state the consequent problem. Candidates who referred to the buckling of the track in some way were awarded credit.

(ii) Possible solutions to the problem mentioned in the previous part were often seen but there were few explanations.

Question 6

(a) This question was very often awarded full credit. However, there were some answers that labelled one compression and one rarefaction and others where the compressions were poorly marked.

(b) There were many good answers here and the wave equation was well known and was usually correctly rearranged. The most common error was for the wavelength to be measured inaccurately or for the wavelength to be taken as the full width of the diagram. Candidates that did not show any working out or any other intermediate detail were rarely awarded any credit.

(c) There was a variety of ways in which candidates could obtain credit in this question but few answers were complete. There were many candidates who realised that increasing the frequency would lead to a reduced wavelength.

Question 7

(a) (i) Almost all candidates sketched a sinusoidal wave of some sort and only a few were so poorly drawn that little or no credit was obtained. Some diagrams did not show exactly two cycles of the alternating electromotive force and only a few candidates labelled the *y*-axis and the *x*-axis.

(ii) Although most candidates who attempted this part marked a P in a correct position, many candidates did not give an answer at all.

(iii) Many candidates were able to give one correct change and often an increased voltage was mentioned. Fewer candidates were able to give a second change that was different and there were candidates who gave answers that treated the two terminals X and Y differently.

(b) A few candidates knew precisely how a transformer operates and gave excellent answers that explained in detail what happens in a transformer when the primary coil is connected to the output of a generator. Other candidates gave rather confused answers which referred to what was happening inside the generator or what happens inside a d.c. motor. Some candidates stated that a transformer turns an a.c. into a d.c.

(c) There were many good answers here and full credit was often awarded. However, some candidates believed that stepping up the transmission voltage reduced the resistance of the cables.

Question 8

(a) Most candidates were able to draw in the symbol for a thermistor. A few candidates gave the symbol for a different circuit component but very few candidates omitted this part.

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(b) This was usually answered correctly. Candidates who were not awarded full credit often tried a more involved calculation, rather than the simple division that was needed. An answer of 96 V was given by several candidates.

(c) (i) The correct answer was often reached and full credit was awarded. However, the most common answer was 533 Ω. This nearly always came from the assumption that the potential difference across the 800 Ω resistor was 12 V.

(ii) Few candidates explained how their conclusion was reached. The simple comment that the voltage increase revealed an increase in the resistance of the thermistor was not sufficient as it did not consider that the current in the circuit must have decreased. The conclusions themselves included all possible combinations of an increased and decreased resistance revealing an increased or a decreased temperature.

Question 9

(a) The nuclide notation symbols were very frequently correct with a small minority of candidates writing the numbers on the right of the Hs or reversing the nucleon and proton numbers.

(b) (i) The two main causes of error were candidates who explained nuclear fusion by using a word such as “fuse” or “fusing” or who made no reference to the involvement of nuclei. A small number of candidates stated what is meant by nuclear fission.

(ii) Only a few candidates were awarded full credit in this part. Many candidates gave the nuclide notations for hydrogen-2 and hydrogen-3 as the products as well as the nuclear reactants.

(c) There were many candidates who obtained at least partial credit here but few gained full credit. A common incorrect answer was that wave energy does not have a solar origin. The term “tidal wave” is a common term for a tsunami rather than an energy source.

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PHYSICS

Paper 0972/51
Practical Test

Key messages

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

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques, including the following:
- plotting graphs
- tabulating readings
- manipulating data to obtain results
- drawing conclusions
- dealing with possible sources of error
- controlling variables
- handling practical apparatus and making accurate measurements
- choosing the most suitable apparatus.

It is assumed that, as far as possible, the IGCSE course will be taught so that candidates undertake regular practical work as an integral part of their study of physics.

Questions on experimental techniques were answered much more effectively by candidates who showed evidence of undertaking regular practical work. Some candidates appeared to have learned sections from the mark schemes of past papers and written responses that were not appropriate to the questions set.

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

Comments on specific questions

Question 1

(a) The majority of candidates successfully recorded the *d* value in cm. Some appeared to have taken the measurement from the figure instead of from their apparatus.

(b) (c) Most candidates recorded realistic *t* values and completed the calculations of *T* correctly. T^2 values were expected to be given to consistently three or consistently four significant figures. Candidates carrying out the experiment correctly obtained increasing T^2 values.

(d) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates chose a scale that resulted in the plots occupying too small a proportion of the graph grid. Plotting was generally accurate. Candidates should use neat crosses for the plots, or neatly

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circled dots so that the accuracy of the plotting can be assessed. Many candidates drew a well-judged straight line but some drew a dot-to-dot line whilst others drew a straight line that did not match the plots.

(e) Here candidates were expected to realise that timing errors at the beginning and end of the timing period are less significant when timing 10 oscillations. Some candidates appeared to refer to 10 separate timings of one oscillation giving an average result, not realising that a single time for 10 oscillations is the technique involved.

Question 2

(a) Most candidates recorded realistic values for current and potential difference and calculated the resistance correctly.

(b) Candidates who had rearranged the circuit correctly obtained a value for I_2 less than I_1. Correct use of the units A, V and Ω was credited here.

(c) Candidates were credited for completing the third set of readings with I_3 greater than I_1 and then for carrying out the calculation to obtain the value of R_P less than the value of R_1.

(d) Candidates were required to draw two resistors in parallel and have a complete circuit with correctly positioned ammeter and voltmeter with all the correct circuit symbols used.

(e) Candidates gained partial credit for suggesting the use of additional resistors. Some candidates realised that, in order to obtain a result with convincing validity, at least five sets of results would be required, adding a resistor each time.

Question 3

(a) Most candidates drew the normal and lines **EF** and **GH** accurately.

(b) Many candidates accurately drew the line **PQ** at 30° to the normal but some drew the line at 60° to the normal. Fewer candidates placed the pins P_1 and P_2 correctly at a distance of at least 5 cm apart.

(c) Most candidates measured the distances *a* and *b* correctly, but some did not include a correct unit (cm or mm). Calculations of *b*/*a* were usually correct, but a significant number of candidates did not realise that the ratio has no unit.

(d) A significant number of candidates incorrectly suggested carrying out the experiment in a darkened room. Successful candidates made valid suggestions such as viewing the bases of the pins.

(e) Candidates were expected to suggest at least four additional angles of incidence with a range of at least 30° and all less than 90°.

Question 4

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

Candidates needed to include a stop-watch (or other timing device) for initial credit to be awarded.

A concise explanation of the method was required. Candidates should concentrate on the readings that must be taken and the essential parts of the investigation. It may benefit candidates to plan their table of readings before writing the method to help them to think through the measurements that must be taken in order to address the subject of the investigation. Candidates were expected to note that the block must be removed from the hot water and then the temperatures taken over a period of time. Candidates then needed to make it clear that the procedure was repeated with blocks made of different metals. A vague reference to repeats was not sufficient as it was not clear whether candidates were referring to using different blocks or repeating the measurements with the same block.

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Candidates were expected to identify at least one variable to keep constant. The dimensions of the blocks or the starting temperature of the hot water were correct suggestions.

Many candidates drew a suitable table. They were expected to include columns for the metal of the block, temperature and time with appropriate units.

Candidates were expected to explain how to reach a conclusion. A graph of temperature against time for each metal was a suitable suggestion or an explanation of how to relate the temperature drop for each metal to the rate of cooling. The question did not ask for a prediction. Some candidates wrote a prediction, but no explanation of how to reach a conclusion.

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PHYSICS

Paper 0972/61
Alternative to Practical

Key messages

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

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical physics techniques, including the following:
- plotting graphs
- tabulating readings
- manipulating data to obtain results
- drawing conclusions
- dealing with possible sources of error
- controlling variables
- handling practical apparatus and making accurate measurements
- choosing the most suitable apparatus.

It is assumed that, as far as possible, the IGCSE course will be taught so that candidates undertake regular practical work as an integral part of their study of physics.

Questions on experimental techniques were answered much more effectively by candidates who showed evidence of undertaking regular practical work. Some candidates appeared to have learned sections from the mark schemes of past papers and written responses that were not appropriate to the questions set.

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

Comments on specific questions

Question 1

(a) The majority of candidates successfully recorded 50 cm. Some appeared to have taken the measurement from the figure instead of from the information in the question.

(b) Most candidates calculated T and T^2 correctly. T^2 was expected to be given to three significant figures to be consistent with the other values in the table. Most candidates successfully gave the units, cm for distance and s for time, but many did not realise that the unit for T^2 is s^2.

(c) Most candidates labelled the graph axes correctly and drew them the right way round. Some candidates chose a scale that resulted in the plots occupying too small a proportion of the graph grid. Plotting was generally accurate. Candidates should use neat crosses for the plots, or neatly

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circled dots so that the accuracy of the plotting can be assessed. Many candidates drew a well-judged straight line but some drew a dot-to-dot line whilst others drew a straight line that did not match the plots.

(d) Very few candidates realised that the line must pass through the origin to show a proportional relationship. Some candidates thought that a straight line was sufficient to show proportionality.

(e) Here candidates were expected to realise that timing errors at the beginning and end of the timing period are less significant when timing 10 oscillations. Some candidates appeared to refer to 10 separate timings of one oscillation giving an average result, not realising that a single time for 10 oscillations is the technique involved.

Question 2

(a) Most candidates recorded correct values for current and potential difference and included the units A and V. Most candidates calculated the resistance successfully, but the unit required was not always given.

(b) Here credit was awarded to those candidates who gave the resistance to 2 or 3 significant figures.

(c) Most candidates calculated the resistance correctly.

(d) The diagram required candidates to draw two resistors in parallel and have a complete circuit with correctly positioned ammeter and voltmeter with all the correct circuit symbols used.

(e) Candidates gained partial credit for suggesting the use of additional resistors. Some candidates realised that, in order to obtain a result with convincing validity, at least five sets of results would be required, adding a resistor each time.

(f) Successful candidates drew a clear variable resistor symbol. Others drew the thermistor symbol or a symbol that appeared to be a cross between a variable resistor and a thermistor.

Question 3

(a) Most candidates drew the normal correctly.

(b) Most candidates drew the lines **EF** and **GH** carefully and in the correct positions.

(c) Many candidates successfully drew the line **PQ** at 30° to the normal but some drew the line at 60° to the normal. A minority chose 45°. Candidates were expected to know that the pins P_1 and P_2 should be positioned at a distance of at least 5 cm apart.

(d) Most candidates measured the distances *a* and *b* correctly, but some did not include a correct unit (cm or mm). Calculations of *b*/*a* were usually correct, but a significant number of candidates did not realise that the ratio has no unit. Candidates who had followed the instructions with care obtained a value of *b*/*a* that was within the tolerance allowed.

(e) A significant number of candidates incorrectly suggested carrying out the experiment in a darkened room. Successful candidates made valid suggestions such as viewing the bases of the pins.

(f) Candidates were expected to suggest at least four additional angles of incidence with a range of at least 30° and all less than 90°.

Question 4

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

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A concise explanation of the method was required. Candidates should concentrate on the readings that must be taken and the essential parts of the investigation. It may benefit candidates to plan their table of readings before writing the method to help them to think through the measurements that must be taken in order to address the subject of the investigation. Candidates were expected to note that the block must be removed from the hot water and then the temperatures taken over a period of time. Candidates then needed to make it clear that the procedure was repeated with blocks made of different metals. A vague reference to repeats was not sufficient as it was not clear whether candidates were referring to using different blocks or repeating the measurements with the same block.

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