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FOREWORD

This booklet contains reports written by Examiners on the work of candidates in certain papers. **Its contents are primarily for the information of the subject teachers concerned**.

PHYSICS

GCE Advanced Level and GCE Advanced Subsidiary Level

Paper 9702/01

Paper 1 - Multiple Choice

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

General comments

This Paper worked very well in giving candidates who knew their physics an opportunity to show what they knew and understood, while at the same time providing good discrimination. The pattern of the Paper is to work sequentially through the main sections of the specification and to increase the difficulty of questions within each specification section. This does mean that there are some easy questions at the beginning of the Paper and at the commencement of each section of work. Candidates should have to work at a reasonable speed in order to complete the Paper within the time allowed so no candidate should spend an undue amount of time on any particular question. A routine that maybe used can be practised in advance so that sensible candidates work steadily through the Paper answering those questions which they can do immediately and omitting those for which they need more time, - making certain they use the correct spaces on the answer sheet. On a second run through the Paper they can then deal with the questions about which they are uncertain. In this way there is no danger of a large batch of questions being left untackled at the end of the Paper. They should, as a last resort, make intelligent guesses so that their answer sheet contains no blank spaces. Working has to be done on the Question Paper. There is plenty of spare space for this and working on paper should be done. Far too many careless mistakes arise from working just in ones head or just on a calculator.

Comments on specific questions

Questions are designed to have a facility of between 25% and 80%. That is between 25% and 80% correct answers. They should also produce positive discrimination. All the questions on the Paper had positive discrimination.

Question 1

This was a very easy starter question which nearly everyone got correct.

Question 2

Another straightforward question with a high facility.

Question 3

This question was also answered well and had good discrimination.

Questions 4 – 8

These mechanics questions were all done well, with about 50% or more correct answers.

Question 9

Half of the candidates thought that **C** was the correct response to this question but the more able candidates were able to choose the correct answer, **D**.

Question 11

The Examiners suspect that not enough candidates thought in terms of velocity of approach equals velocity of separation in answering this question. The consequence was that only the most able 13% could see that **A** is the correct response. There was nevertheless good discrimination.

Question 16

This first question dealing with power and energy happily proved to be well answered.

Question 17

This proved to be difficult for the average candidate. Perhaps it was because they are so used to dealing with questions where the loss of potential energy equals the gain in kinetic energy or perhaps because they did not read the question carefully enough. The high scoring candidates however did realise that at constant speed there is zero change in kinetic energy and therefore **D** is the correct response.

Question 20

This proved to be rather easy.

Question 22

This is a good question. It would repay considerable study on behalf of candidate's understanding of solids, liquids and gases but it was correctly answered by a very small 7% of candidates. Two-thirds of candidates thought that **B** was the correct answer but this molecular spacing would imply that solids have a density of 1000 times that of liquids.

Question 24

The analysis required here needs to be done very carefully. Only 36% managed to do it correctly.

Questions 25 - 29

These wave questions were done well although fewer got through to the correct answer for **Question 29** than on the other questions.

Questions 30 - 34

These electrical questions were all done well with around 60–70% correct answers.

Question 35

The statistics for this question indicate that a great deal of guessing took place. Only 20% of the candidates were able to answer this correctly but at least there was good discrimination.

Question 36

This was another question where all of the four options were frequently chosen. The high scoring candidates were able to see that **A** is the correct answer.

Questions 37 - 40

These last four questions were answered well, particularly **Questions 37** and **38** where approximately 80% of candidates were correct.

Paper 9702/02

Structured

General comments

There was a pleasing number of excellent scripts showing a sound understanding of the whole syllabus. Such scripts were generally well presented with clear arguments both in prose and in calculations. As usual, however, standards varied widely.

Blank pages at the end of scripts may suggest that some candidates had insufficient time to complete the questions. However, these blank pages usually appeared in the scripts of weaker candidates and may have resulted from unfamiliarity with the subject content of the final question.

In some questions, time was wasted in the calculation of quantities that were not required. Candidates should be encouraged to recognise which quantities in an equation are constant for the purpose of the calculation, and thereby reduce the calculation to one of proportionality rather than two or three-stage numerical work.

Comments on specific questions

Question 1

(a) Density was defined correctly by most candidates and correct units were given. However, there is a tendency amongst weaker candidates to refer to ‘mass in a certain volume’. For a complete definition, the ratio must be made clear.

(b) In most scripts, the units of the quantities involved were given. However, the final step to show that γ has no unit was rarely clear. In many instances, this final step involved nothing other than the crossing out of units, frequently obliterating the original indices. Clear statements making reference to the homogeneity of the equation were seldom seen.

Question 2

(a) The uncertainty was frequently given as ± 0.1 cm, failing to realise that when two quantities are added or subtracted, the uncertainty in the result is found by summing the individual uncertainties.

(b) Most candidates were successful with this calculation.

(c) There were few correct answers here. In general there was a failure to appreciate that, when quantities are multiplied together or divided, then the uncertainty in the result is found by adding the fractional uncertainties of the individual quantities. Of those who did find a fractional uncertainty in the result, a significant number then failed to convert the fractional uncertainty into an actual uncertainty.

Question 3

(a) This part of the question was done well. Most candidates used either the appropriate area on the graph or an equation for linear motion. Where a value for the acceleration was required, either that deduced from the graph or the acceleration of free fall was considered to be acceptable.

(b) In general, answers here were poor. The majority of candidates either failed to identify correctly the region of the graph for which the ball was in contact with the plate or failed to take into account the change in direction when calculating the change in velocity of the ball.

(c) It was common to find that, where candidates attempted to find the average rate of change of momentum, they used an incorrect value for the time of contact. Some calculations were based on use of the formula $F = ma$. Although this may be appropriate, many answers involved the acceleration of free fall or only the acceleration during the linear change of velocity during contact.

Question 4

(a) Most answers included a mention of the product of ‘force’ and ‘distance’. However, only a minority made it clear that the ‘distance’ is the distance through which the force moves in the direction of the force.

(b) Candidates were expected to derive the expression, rather than quote it. Frequently, there was confusion between ‘height (above ground)’ and ‘change in height’. It was pleasing to see that in some scripts, a clear link was made between work done against the gravitational force and the resulting change in gravitational potential energy.

Question 5

(a) Most candidates did appreciate the basic concept of what is meant by a transverse wave. However, despite the fact that explicit instructions were given in the question, many imprecise explanations were given. Statements such as ‘the wave moves at right angles to the motion’ were not uncommon. A reference to the direction of the displacement and of energy travel was required.

(b)(i) Fewer than one half of the candidates deduced that a phase angle of 60° corresponded to 1 cm along the *x*-axis of the graph and even fewer showed a wave that lagged behind the given wave.

(ii) Most candidates did appear to have some understanding of coherence. However, an appreciable proportion either did not establish that the waves must coincide at some point or made reference to amplitude rather than displacement.

(iii) Although a minority did not appear to understand what was expected, the majority did read off values from the graph and then gave a resultant displacement consistent with their values. Weaker candidates frequently ignored whether the displacement was positive or negative.

Question 6

(a)(i) Most candidates correctly showed the direction of the electric field although there were some very careless drawings that were not given credit.

(ii) Most sketches indicated a curved path in the correct direction. However, credit was frequently lost because the curvature did not begin until the electron was well into the region of the electric field. It was frequently difficult to decide on the path once the electron had left the electric field. In many drawings, the line was only a few millimetres long. Where a longer line was drawn, this was often curved or clearly not tangential to the path at the edge of the field.

(b) This calculation was completed successfully by most candidates. The most common error was a failure to convert the unit for the separation.

(c) There were many correct answers to both calculations. Incorrect formulae used by some candidates showed that they were confused between electric field strength and potential.

(d) Answers were, in general, disappointing. In many scripts, there appeared to be a lack of understanding of what is meant by 'horizontal component' and as a result, incorrect statements based on the force due to the electric field acting at right angles to the direction of motion were common.

Question 7

(a) A common error was to assume that the total resistance of the circuit was 60 Ω, thereby ignoring internal resistance of the battery and any other resistance in the circuit. Those candidates who recalled that e.m.f is energy converted per unit charge and that current is charge passing per unit time had little difficulty with the calculations.

(b)(i) Those candidates who realised that, for constant current, energy dissipated is proportional to resistance had no difficulty with this calculation. Others made cumbersome, but correct, calculations, even re-calculating given data such as the time.

(ii) Attempts to justify the 'loss' of energy were frequently fundamentally unsound and confirmed earlier suspicions that the internal resistance of the battery had not been considered.

Question 8

(a) The majority of answers were correct but a significant minority did give the neutron number for the nucleon number.

(b) Although the majority of answers were correct, it was not uncommon to find an equation implying bombardment of the francium nucleus by the alpha particle rather than alpha particle decay.

Question 9

(a) Candidates who knew expressions for stress, strain and the Young modulus had little difficulty with these calculations, most errors being algebraic or arithmetical. However, a significant number of answers indicated a lack of knowledge of this topic.

(b) Most candidates who attempted this calculation did give an expression for resistivity but very few went on to give a correct solution using simple proportion. The majority calculated a value for the resistivity. However, when they then found the final resistance, they used insufficient significant figures in the value for the resistivity, resulting in an apparent decrease in resistance for the stretched wire. Candidates who 'carried' the value in their calculators frequently arrived at the correct result.

Paper 9702/03

Practical 1

General comments

The performance of candidates was very similar to last year. Candidates generally found the Paper quite accessible, with the bulk of the marks ranging from about twelve to twenty-three. It was very pleasing to see a proportion of the most able candidates scoring full marks (twenty-five marks).

Very little help was given to candidates from Supervisors. Virtually all candidates were able to obtain an appropriate number of readings in the allocated time. There was no evidence of candidates running short of time.

There appeared to be no significant problems for Centres in obtaining the apparatus required for the experiment.

Comments on specific questions

Question 1

Most candidates were able to set up the apparatus and take six sets of readings for *T* and *d*. Most candidates presented the results in tabular form with correct column headings. Occasionally the units had been given in the body of the table of results and not at the head of the columns of results. This was not accepted. A number of the weaker candidates gave the values of *d* to an inappropriate number of decimal places. It is expected that the values of *d* will be given to the nearest millimetre as a rule with a millimetre scale being used to make the measurement.

Most candidates repeated the readings of time and calculated the period *T* correctly. When mistakes had been made it was usually because candidates had divided the number of oscillations by the time giving frequency instead of period. It was pleasing to see that most candidates used a sufficiently large number of oscillations of the suspended magnet so that the raw times were not too small (candidates were penalised if most of the raw times were less than ten seconds). Very weak candidates recorded *T* directly (perhaps they had just measured the time for one oscillation).

Candidates were required to draw a graph of *T* against *d*. It was pleasing to see that most candidates did this quite well, and that the quality of graphical work is improving. Weaker candidate still tended to make life difficult by choosing awkward scales (e.g. 3 units corresponding to ten small squares). This often led to plotting errors and misread scales when finding a gradient or an intercept. Candidates should be encouraged to use scales that are simple and easy to work with (e.g. 2:10 or 5:10). Some of the weaker candidates chose to use compressed scales (where the plotted points occupied less than half the graph grid in either the *x* or *y* directions, or both). The graph grid measures eight large squares (in the *x*-direction) by twelve large squares (in the *y*-direction) and therefore it is expected that the plotted points would occupy at least four large squares in the *x*-direction and six large squares in the *y*-direction. It is expected that all the observations will be plotted to an accuracy of half a small square on the graph grid. Plots in the margin area are not acceptable.

One mark was available for the 'quality of results'. This was judged on the scatter of points about the line of best fit. Candidates who had done the experiment carefully were able to score here if the scatter of points was small.

The calculation of the gradient of the line was usually done well, although a number of weaker candidates used small triangles when finding $\Delta y / \Delta x$. It is considered good practice to use triangles where the length of the hypotenuse is at least half of the length of the line that has been drawn. It is expected that the read-offs will be read to half a small square.

Candidate's determination of the *y*-intercept was usually done well (either by calculation using $y = mx + c$ and a point on the line, or direct reading from the *y*-axis).

Most candidates correctly equated the gradient and *y*-intercept with *k* and *c* respectively. Weaker candidates tended to omit the units, or give the values to an inappropriate number of significant figures. Since there is a degree of judgement involved in drawing a line of best fit it was felt that *k* could not be given to more than three significant figures. Candidates who wrote down the numbers as they appeared in the calculator display lost marks here.

In part **(d)** candidates were asked to explain whether or not the results of their experiment would support the suggestion that *T* is directly proportional to *d*. Very weak candidates did not attempt this section. Vague responses were often seen, such as 'My graph is a straight line and so this is true'. In order to gain full credit here candidates needed to state clearly that the line did not pass through the origin, and therefore the suggestion is invalid.

In part **(e)** the more able candidates were able to gain full credit for a correct determination of *T* for a separation *d* of 5 mm using the graph or the equation. When errors had been made it was usually due to incorrect use of powers of ten in converting units. Some candidates made basic errors and obtained a negative value for the period (?), which was not credited. In the last section the more able candidates realised that the magnets would stick together at this small separation, or that the oscillations would be too quick to time manually using a stopwatch. Weaker candidates gave answers such as 'The magnets attracted each other and therefore the time could not be measured', which was considered to be too vague for credit to be given.

Paper 9702/04

Core

General comments

The abilities of the candidates varied widely. There were some very good candidates but on the other hand, some candidates appeared not to be well-prepared for the examination.

There is a tendency for candidates to supply answers without showing any working, especially where the calculation involves only one stage. This practice should be discouraged since, if the answer is incorrect, it does not enable any credit to be awarded for the working.

With some exceptions, all questions were attempted and candidates appeared to have sufficient time to complete their answers.

Comments on specific questions

Question 1

(a) For those candidates who could recall the relevant equations, then the calculations presented few problems. The most common errors were in the time of heating. In **(i)**, a small number of answers involved the addition of the number 273, presumably because the unit of specific heat capacity involves degrees kelvin.

(b) It was pleasing to note that the majority of answers involved thermal energy losses to the atmosphere, with candidates drawing the correct conclusion. A common error was to try to involve energy gains by the material of the kettle.

Question 2

(a) With few exceptions, candidates were able to determine the photon energy although this was usually done by reference to basic equations. It would have been much quicker for them if they had realised that energy is inversely proportional to wavelength and thus used proportionality.

(b) A surprisingly large number of diagrams had the energy level in an inappropriate position, despite having calculated the correct value. Generally, the energy change to level L was shown correctly. However, very few candidates appreciated the connection between the energy levels and thus drew in a fourth level at 1.06×10^{-19} J.

Question 3

(a)(i) The majority of candidates recognised that the amplitude is constant. However, some were unable to distinguish between amplitude and displacement and thus referred to 'constant displacement'.

(ii) The calculation presented very few problems for more able candidates. However, some weaker candidates calculated the frequency, rather than the angular frequency, despite being given the unit on the answer line.

(iii) The maximum speed could be determined either by calculation or by use of the gradient at the appropriate position on the line of Fig. 3.2. Most candidates chose the calculation and were successful.

(b)(i) In general, candidates calculated correctly the frequency from Fig. 3.2 without making any written comment.

(ii) Very few candidates scored marks in this part of the question. They were expected to realise that the force would provide a pulse of energy on alternate cycles and thus cause a build-up of the amplitude. However, most attributed the effect to resonance, stating that the frequency $\frac{1}{2}f_o$ would be the resonant frequency.

Question 4

(a) With few exceptions, appropriate equations were quoted. However, explanation was frequently less than adequate and algebraic expressions were not written down in a logical order. Where a question asks for candidates to 'show' some result, then they should be aware of the need for careful explanation of the various steps in the derivation.

(b) A surprisingly large proportion of candidates scored full marks for this calculation. However, they did tend to calculate values of quantities that were not required (e.g. the kinetic energy or v^2), rather than carry out some algebraic manipulation of relevant equations, followed by a simple numerical substitution. This latter procedure would have saved them some time.

Question 5

The complication of having a safe working voltage increased the level of difficulty of this question for weaker candidates. It was common to find that a circuit was drawn without any input or output leads, thus invalidating the drawing. A large number of candidates drew a circuit having a capacitance of 32 μF, rather than 72 μF.

Question 6

(a) Only a minority of candidates scored full marks here. Many candidates gave inadequate statements such as 'there is always a force in an electric field, but not in a magnetic field'. Candidates were expected to consider the effect of the magnitude of the speed, and of the direction of motion relative to the direction of the fields, on the magnitude of the force. Short concise statements relative to each field were sufficient.

(b) With few exceptions, the direction of the field was predicted correctly. The majority of candidates were able to complete the calculation correctly. However, as in **Question 4 (b)**, rather than combine the relevant equations and then make a numerical substitution, many elected to calculate the force using $F = Bqv$, and then substitute this value into the equation for centripetal force. Full credit was given for this approach but candidates may disadvantage themselves as regards the extra time required.

(c) Surprisingly, a significant number of diagrams showed the electric field acting down the page. For candidates who could recall the relevant equations, the calculation presented very few problems.

(d) In situations where candidates are asked to comment on the magnitude of a quantity, it is insufficient to merely state 'large' or 'small'. Candidates should be encouraged to make a comparison. In this case, they should realise that the gravitational force is small in comparison with either the magnetic or the electric force. In some scripts, gravitational force was compared, quite wrongly, with electric or magnetic field strength.

Question 7

(a) Despite the explicit instruction to refer to relevant laws, some candidates attempted an explanation without a reference to Faraday's law in **(i)** and Lenz's law in **(ii)**. There was a marked tendency towards vagueness, possibly as a result of a lack of understanding. For example, it was common to find 'there is a change in magnetic flux' when, in fact, there is no change in flux but a cutting of flux by the wire.

(b) Full credit was achieved in this part of the question by only the more able candidates. Less able candidates scored some marks for a correct identification of the peak value and of the time period. It is expected that, in numerical answers, the final answer is fully evaluated and not left as a vulgar fraction.

Question 8

(a) There was a widespread failure to appreciate that the radioactive decay constant is the probability per unit time of decay of a nucleus. Many believed that it is defined by reference to the relation *activity* $\propto$ *number of nuclei.*

(b) Most candidates did use the given symbols and scored the mark. A minority became confused by attempting to give the activity as d*N*/d*t*, and then deducing that d*N*/d*t* = λA.

(c) In general, candidates either had very little idea as to how to complete any of the calculations or they scored well. In **(i)**, there was some confusion between moles of gas and the number of molecules. With few exceptions, they were able to complete **(ii)**, based on the answer to the previous part. In **(iii)**, it was pleasing to note that most of the candidates who had calculated a value for the number of radon atoms were then able to go on to calculate an activity.

Paper 9702/05

Paper 5 - A2 Practical

General comments

The general standard of the work by the candidates was very similar to last year. The wide range of marks scored reflected the wide range of abilities of candidates. It was clear that some candidates had prepared well for this examination, especially in the practical **Question 1**. Generally the marks for **Question 1** were better than the marks for **Question 2**. Supervisors gave very little help to candidates.

The vast majority of Centres did not have difficulty in obtaining the required apparatus for the experiment in **Question 1**, and generally the experiment was performed as intended.

Weaker candidates found the design question difficult, and candidates' answers to this question were generally disappointing. There was no evidence that candidates were short of time, although a number of very weak candidates did not attempt **Question 2**.

Comments on specific questions

Question 1

In this question candidates were required to investigate a simple form of current balance using a metre rule attached to a magnadur magnet placed near to a current-carrying coil. Most candidates were able to take six sets of readings for current ***I*** and distance ***d*** of the suspended mass. A number of weaker candidates misread the reading on the rule and obtained data with an incorrect trend. It is expected that the readings will be repeated. Often this was not the case, especially with the weaker candidates.

Most candidates presented the results in a table with correct column headings. A solidus notation is preferred (i.e. ***d***/cm rather than ***d*** *(cm)).* Some of the weaker candidates omitted the units in the column headings. Values of ***d*** in the table were sometimes given to a whole number of centimetres instead of to the nearest millimetre. It is expected that millimetres will be used since a rule with a millimetre scale is used to make the measurement of ***d****.*

Candidates were required to plot a graph of ***I*** against ***d****.* Most of the more able candidates were able to do this quite well, although the weaker candidates tended to use awkward scales (e.g. three units corresponding to ten small squares) or compressed scales (where the plotted points occupied less than half the graph grid in either the *x* or the *y* direction). It is expected that the axes will be labelled with the quantities plotted.

Data values were usually plotted correctly (allowing a tolerance of half a small square) and lines of best fit drawn quite well. It may be helpful to candidates if they could be encouraged to use clear plastic rules when drawing the line. This is because all the points can be seen when the line is drawn, and therefore it is easier to judge the balance of points. The line of best-fit mark was sometimes not awarded because points that were not on the line were all to one side of the line (either above or below) instead of being reasonably scattered about the line.

One mark was available for the 'quality of results'. This was judged on the scatter of points about the line of best fit. The candidates who had done the experiment carefully and read the rule and the ammeter correctly were able to score this mark if the scatter of points about the line of best fit was small.

Candidates were instructed to find the gradient of the line. It is expected that candidates will use well-spaced co-ordinates on the line when determining the gradient. Candidates should use triangles where the length of the hypotenuse is at least half the length of the line that has been drawn. Small triangles were penalised. Candidates using values from the table where the points did not lie on the line of best fit were not given credit here.

Most candidates realised that a calculation was needed to find the *y*-intercept using $y = \mathrm{m}x + \mathrm{c}$ and a point on the line. This method had to be used to avoid compressed scales on the graph. A number of the weaker candidates stated a value for the *y*-intercept from a line where ***d*** was not equal to zero (i.e. a 'false origin' had been used).

The analysis section in this Paper was felt to be quite straightforward, and many candidates scored well if they identified the gradient with m and the *y*-intercept with c. A few candidates omitted units with their answers (A m^{-1} and A respectively). It is expected that the values of m and c will be given to a sensible number of significant figures. As there is a degree of judgement required in drawing a line of best fit, it was felt that m and c could not be given to more than three significant figures.

In part **(f)** candidates were required to suggest how to use the apparatus to measure an unknown current if the ammeter were to be removed from the circuit. Most candidates were able to suggest using a value of *d* with either the graph or the equation to find a value for ***I***. Weaker candidates usually did not attempt this section.

Question 2

In this question candidates were required to design an experiment to investigate how the resonant frequency of a wire vibrating in its fundamental mode depends on the tension in the wire. This question was not answered well by the weaker candidates and was often not attempted. Many answers lacked detail, and it was clear that large numbers of candidates had never seen a stationary wave.

It was expected that a vibration generator connected to a signal generator would be used to generate waves on the wire, and the frequency would be adjusted until a stationary wave (fundamental) was observed for a particular tension in the wire.

Many candidates were very confused about the form of the experiment, and a wide variety of inappropriate methods were seen. Weaker candidates suggested using stopwatches to 'time the oscillations of the wire' and attempted to determine the frequency using $f = 1/T$. If an oscilloscope had been employed it had often been used incorrectly (e.g. attached to the ends of the wire). Many scripts were seen where the wavelength of the standing wave on the wire had been confused with the length of a wave seen on the oscilloscope screen. Where frequency measurement was made indirectly by either the use of a CRO or a stroboscope, credit was usually given, although candidates' responses lacked detail. Few candidates suggested a straightforward 'read the frequency from the scale on the signal generator'.

There was general confusion about how to excite oscillations in the wire. A number of candidates suggested attaching masses to the centre of the wire, and attempted to use the vibrations of the mass to generate waves on the wire. Unworkable methods such as these did not score very well.

Candidates were directed in the question towards the control of variables (part **(d)**). Surprisingly large numbers of candidates described experiments where the *length* of the vibrating wire was changed as well as the tension.

Many candidates lost marks by not stating how the tension in the wire would be found (i.e. straightforward '$T = mg$' or 'weight of the suspended mass' ideas).

Disappointingly few references were made to safety. There were several ways that candidates could score here (e.g. use of safety goggles or safety screens in case the wire snaps).

As in previous questions of this type marks were available for any 'good further design features' that were felt to be creditworthy. Some of these are as follows:

- Place a white card behind the vibrating wire so it can be seen easily
- Check frequency scale of SG/calibration ideas
- Good description for finding resonance position

- Use top pan balance/electronic scales to find mass
- Do preliminary experimentation to determine suitable loads
- Detail relating to how the frequency would be found from the CRO trace
- Use a screw gauge to check the uniformity of the wire
- Sensible ideas relating to the elastic limit
- Perform the experiment in a quiet place (if using a microphone and CRO)
- Check the wire to ensure that it is free from kinks.

Paper 9702/06

Options

General comments

The general standard of the work of candidates was disappointing. The impression gained was that the Options had not been studied in sufficient depth and that candidates had a very superficial knowledge of the topics. Where discussion was required, answers were frequently expressed in simplistic non-scientific terms.

With very few exceptions, candidates did attempt two Options. By far, the most popular of these were ***Options F*** and ***P***. However, popularity cannot be equated with high scores.

Judging by the number of unanswered parts to questions, candidates appeared to have sufficient time to complete their answers.

Comments on specific questions

Option A

Question 1

It was common to find that candidates scored either full marks for this question or none at all. There were some candidates who, quite clearly, had no concept of the distances involved. Quoting the time for light to travel from Sun to Earth as years and to the nearest stars as thousands of years indicates a lack of appreciation of fundamental ideas.

Question 2

(a) Most answers did involve relative motion. However, there was some difficulty in expressing the idea that the light emitted appears to have a longer wavelength.

(b) Candidates did not appear to appreciate that any change cannot be detected unless reference wavelengths, as provided by a line spectrum, are available. Furthermore, the idea that the whole of a continuous spectrum would shift, and thus give no apparent change, was mentioned in very few scripts.

(c) Light pollution and irregular refraction were mentioned frequently. Weaker candidates found difficulty in identifying a third factor, such as atmospheric absorption.

Question 3

(a) The calculation of the mean density presented very few problems. However, it was common to find that this mean density was assumed to be the number density of nucleons.

(b)(i) Pleasingly, many candidates made a reference to dark matter. However, only a minority realised that there is a limit to the observable Universe.

(ii) In general, this part of the question was done well although some answers did not include the fact that expansion must come to a halt before collapse can occur.

Option F

Question 4

(a) A significant number of candidates gave a statement of Archimedes' principle when all that was required is that an upthrust is a force acting upwards.

(b) Again, many answers involved a statement of Archimedes' principle. Others merely mentioned pressure difference in a fluid. What was required was a clear statement giving the relative pressures on the lower and upper surfaces of the body, leading to the difference in the force on these surfaces.

(c) Many answers made reference to floating or the relative densities of the fluid and the object. In only a minority of scripts was there a mention of incompressibility of the fluid and of the object.

Question 5

(a)(i) In nearly half of the scripts, candidates had mis-read the question and given a description of what is meant by streamline flow.

(ii) The concept of a tube of flow was known quite widely, with reference being made to a 'bundle' of streamlines.

(iii) Candidates usually answered this part by mentioning that streamlines cannot be crossed in streamline flow.

(b) The general standard of diagrams was very poor. Candidates need to consider carefully the smoothness of the lines and to pay attention to their relative separation. In the vast majority of scripts, the separation of streamlines in streamline flow varied quite randomly along lines and between pairs of lines. With few exceptions, a change required for turbulence was given. However, candidates should be warned to give the direction of any change. For example 'change in speed' was not accepted. What was required was 'increase in speed'.

Question 6

(a)(i) Very few candidates discussed the fact that there are frictional forces between the various layers in the fluid and that the layer in contact with the surface is not moving. Generally, reference was made only to some friction between the fluid and the surface.

(ii) Many candidates gave the definition as 'ratio of velocity and distance'. Change in velocity was required. Also, candidates were expected to discuss the relative direction of the velocity and the direction in which the change takes place.

(b) There were many correct answers to this calculation. However, it was common to note that, in the substitution, the thickness of the layer and the distance moved were interchanged.

Option M

Question 7

(a) Sharpness and contrast were frequently confused. Furthermore, sharpness was thought to be resolution. *Sharpness* was usually identified with anode area and *contrast* with differences in attenuation coefficient, although statements were frequently imprecise.

(b)(i) There was a widespread misunderstanding of what was required in this question. Candidates were expected to state that there is a continuous distribution of energies with a maximum at 80 keV and with sharp peaks superimposed on the distribution. Instead, there were vague statements related to what is meant by photon energy.

(ii) Apart from some errors with units, this calculation was completed successfully by the majority of candidates.

(iii) Many thought that the linear absorption coefficient is independent of photon energy. Those who did realise that the beam would be more penetrating often deduced, quite wrongly, that the coefficient would be larger.

Question 8

(a) Most candidates made a reference to the forming of focused images but many failed to mention that this focusing is for objects that are at different distances from the eye.

(b) Although most answers included a correct distance for the star and for the book from the eye, the calculation was faulty. These two distances were substituted into the lens formula and the resulting power assumed to be the change in power of the eye. No reference was made to the image distance for the image on the retina.

Question 9

Generally, candidates could give an expression for intensity level in terms of intensities. Also, they were aware of the fact that loudness depends on frequency and on the individual. However, they found difficulty in explaining any link between loudness and intensity level.

Option P

Question 10

(a) With few exceptions, answers to this part of the question were satisfactory.

(b)(i) A minority of answers assumed large power outputs from the solar cells but generally, a sensible use was given. The most common answer being the energy source for a calculator.

(ii) Many candidates associated the surface area of a single cell with the e.m.f generated. Although the question asked for a quantitative approach, there were many vague statements such as 'the cells would cover a very large area'. Most answers included a reference to the dependence of power output on the hours of sunlight. However, very few mentioned that cells generate d.c, not a.c.

Question 11

(a) The majority of answers were correct as regards the directions of the changes. However, very few gained any credit for the direction of the energy transfers. Most thought that the energy would be transferred along the direction of the various changes, rather than into, and out of, the enclosed area.

(b) The drawings of the Sankey diagram were very disappointing. Many drew numerous ouput arrows. Of those who did show only two output arrows, very few drew them with their widths in the correct proportion. Furthermore, many were not labelled correctly.

(c)(i) A surprisingly small number of candidates wrote down an expression for efficiency. Many divided the energy wasted by the input energy, without giving any explanation, and thus lost all the available marks.

(ii) Despite the reference to the second law in the question, many candidates merely made a comment based on the fact that there are always some energy losses. Of those who did give an expression for efficiency in terms of input and output temperatures, with few exceptions they failed to discuss any practical limit for the higher temperature.

Question 12

A surprisingly large proportion of candidates thought that electric cars do not produce pollution. Candidates were expected to realise that both types of vehicle are the cause of pollution since electrical energy has to be generated, but the site of this pollution is different. Noise pollution could also be considered.

Option T

Question 13

(a) Candidates were expected to realise that such a signal consists of a series of pulses between two levels. However, many answers were based on the ease of storage of the signal.

(b) The outcome of this calculation was much as predicted. Able candidates were successful. However, less able candidates produced some ridiculous answers. These were accepted without comment.

(c) In general, candidates had little or no difficulty in identifying an advantage and a disadvantage.

Question 14

(a)(i) Most candidates did refer to energy loss in the fibre but they did not mention the connection between energy and the area under the line of Fig. 14.1.

(ii) Very few marks were scored in this part. Most candidates attributed the change to a change in speed as the pulse moves along the fibre. Only very rarely were multiple reflections mentioned.

(b) The consequence of this failure to recognise that the effect in **(a)(ii)** is due to multiple reflections meant that the calculation was performed without any satisfactory explanation. Furthermore, very few answers involved 7.0 μs.

Question 15

(a) The serious lack of knowledge and understanding of the topic on the part of some candidates was exemplified by the answers given. Answers varied from 10^{-10} m to 10^{5} m.

(b) Frequently, sky waves were not identified with ionospheric reflection. However, most candidates could give some indication of the disadvantages of communication using the ionosphere.

Paper 9702/08
Paper 3 - Practical Test
(Mauritius Only)

General comments

This was the first of the new style papers where a data analysis question had been included with a practical question. Generally candidates found the Paper to be quite accessible, and there was a wide spread of marks. It was pleasing to see the most able candidates scoring marks at or close to the paper maximum.

Supervisors gave very little help to candidates in the practical question. There was no evidence that candidates were short of time.

Centres did not have any difficulty in obtaining the required apparatus for the experiment in **Question 1**, and generally the experiment was performed as intended.

Comments on specific questions

Question 1

(a) Most candidates took six sets of readings of t and d and nearly all repeated the readings. It is expected that an average value of t will be calculated. Most candidates were able to determine the period correctly, although a few found frequency instead of period (i.e. divided the number of oscillations of the rule by the time instead of the other way round). Virtually all candidates calculated $1/d^2$ correctly.

(iv) Candidates were asked to state one way of increasing the accuracy of the value of T. A number of candidates did not realise that they had to suggest an improvement on what they had already done. Some candidates suggested 'repeating the readings', which was not credited, as it was made clear in the question that this answer was not required. Use of a fiducial marker, or timing a larger number of oscillations would have been acceptable.

(v) Most candidates presented the results in tabular form with correct column headings. Occasionally the unit of T^2 had been omitted or given incorrectly as s instead of s^2. The weaker candidates often omitted the unit at the head of the column of values for $1/d^2$. It is expected that a solidus notation will be used to distinguish between the quantity and the unit.

Candidates should record the raw readings in such a way that they are consistent with the apparatus used to make the measurement. Since a rule with a millimetre scale is used to measure d it is expected that all the values of d will be recorded to the nearest millimetre. Some of the weaker candidates gave values of d to the nearest centimetre, which was not acceptable.

(vi) Candidates were asked to justify the number of significant figures that they had given for d^2. It was expected that the number of significant figures in the values of d^2 would be related to the number of significant figures in d. Some candidates referred to 'raw data' and did not make it clear that the number of significant figures in d^2 related to d and not t. Other candidates were confused between significant figures and decimal places.

(b)(i) Candidates were required to plot a graph of T^2 against $1/d^2$. Generally this was done quite well. There were few awkward scales (e.g. 3:10 or 6:10).

(ii) Most candidates were able to plot the points correctly, draw lines of best fit and determine gradients correctly. A small number of candidates used triangles which were far too small (leading to significant uncertainties in Δx and Δy). It is expected that the length of the hypotenuse of the triangle used to find the gradient will be greater than half the length of the line that has been drawn. A few candidates miscalculated the gradient (using $\Delta x/\Delta y$ instead of $\Delta y/\Delta x$).

(c) In the analysis section most candidates were able to equate the gradient with $\frac{16\pi^2 l^3}{3g}$ and successfully calculate a value for g. Some candidates (who had not taken enough care with the experiment) obtained values outside the required range of 9.4 m s^{-2} to 10.2 m s^{-2}. Candidates who did not use their gradient value in the working were unable to score these analysis marks. Most candidates were able to give an appropriate unit for g, although sometimes the units were muddled (cm s^{-2} instead of m s^{-2}).

Question 2

(a) In this data analysis exercise candidates were given a set of values for the range and energy of alpha-particles in air. Most candidates were able to calculate values of R^2 and E^3 correctly to an appropriate number of significant figures, although many were not able to explain why plotting a graph of R^2 against E^3 would confirm the stated relationship. It was expected that a linear form of the given equation would be given with some explanation.

(b) Most candidates were able to plot the graph of R^2 against E^3 and obtain a value for the gradient in the range 0.10 to 0.11. A few candidates reversed the axes, in which case the acceptable range for the gradient was 9.1 to 10.0.

(e) Many candidates did not make reference to the origin when making comments about the suggested relationship. A requirement for agreement with the theory was that the graph should pass through the origin as well as be linear.

(f) Candidates were required to find a numerical value for k. Many equations were seen where candidates had not squared k (i.e. the gradient of the graph of R^2 against E^3 had been equated with k instead of k^2). It was expected that the value of k would be in the range 0.316 to 0.332. A common mistake was to calculate k from a single set of values or a single point on the graph. The weaker candidates were often unable to give a correct unit for k, and many became muddled in attempting to convert the units into SI. A unit of cm $MeV^{-3/2}$ would have been perfectly acceptable.

(g) The more able candidates were able to complete this part without difficulty. The correct value for the energy should be 7.31 MeV, although the Examiners allowed a range from 7.20 to 7.43 MeV. Candidates who had made mistakes in arithmetic or algebra were penalised here. The weaker candidates tended to get themselves lost in a mountain of calculation in this section. Finding cube roots often proved to be problematic for the weaker candidates.