CONTENTS

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
Multiple Choice

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

General comments

From both an examining and a statistical view, this paper worked very well. There were no questions which proved inaccessible to all candidates and weak candidates were able to score well on some straightforward questions. Out of candidates who took the test, 56 managed to get all forty questions correct - a fine achievement for them. The mean mark was 27 and less than 1% of candidates failed to score ten marks. The construction of the test arranges that the main sections of the specification are dealt with in sequence, with easier questions on a topic at the commencement of each section followed by questions of increasing difficulty. A disastrous mistake for a candidate to make would occur if, after omitting a question, all subsequent answers were misplaced on the answer sheet. Candidates must be drilled to look at question numbers to ensure that each answer is put on the answer sheet in the correct place. All the questions gave a positive discrimination and, apart from a few easy starters, the proportion of correct answers was between 36% and 90%. Virtually all candidates answered all the questions. This makes sense as a guess cannot reduce a candidate's mark and may enhance it. Intelligent 'guessing' can increase the probability of getting the right answer.

Comments on specific questions

Question 4 was the first question to cause some difficulty. Too many candidates took the uncertainty to be 60° ± 0.5°.

It was good to see high scoring for **Questions 5** and **7**.

Question 8 proved difficult for many. Weaker candidates do not like graphs which do not start at the origin. These candidates gave the velocity against time graph as their answer, option **B**.

Question 12 is tricky with the signs but about half of the candidates managed to get it correct.

Torque is a word candidates often do not like so it was perhaps understandable that only 54% got the easy **Question 14** correct.

Question 16 proved to be one of the most difficult questions on the paper. A careful triangle of forces is needed to sort it out. Weaker candidates just guessed; 38% were correct. Candidates should use space on the paper to work out their answers. It must not be assumed that the answers always can be found by mental working.

Questions 17 and **22** were done mainly well, but **Questions 23** and **24** proved more difficult.

In **Question 23** hardly anyone thought that the amplitude was 4 cm but many did not appreciate that the displacement, though drawn on the *y* axis, may be the displacement in the direction of travel of the wave.

In **Question 24** only half of the candidates realised that 2½ waves occupied 30 cm.

Again only half the candidates answering **Question 26** could establish the sequence, stationary waves, echoes, interference and diffraction and even fewer realised in **Question 27** that coloured fringes would be observed when using a white light source.

Question 31 proved to be the most difficult question on the paper, with 2.0A being, perhaps predictably, the most common wrong answer.

The next eight questions posed few problems. This is encouraging since often it is these questions which cause difficulty.

Even **Question 40**, which involved a new idea for the candidates, was answered correctly by 52% of candidates.

Paper 9702/02

Structured Questions

General comments

As is usually the case, candidates generally scored higher marks on numerical rather than descriptive questions. Comparatively few candidates showed sufficient knowledge of the whole syllabus for them to complete the full range of calculations. Weaker candidates were able to find some sections that they could complete satisfactorily and consequently there was a wide spread of marks.

Some calculations could be completed entirely on a calculator and many candidates gave only the answers, without showing any working or giving any explanation. Candidates are advised to show their working. All too often, a minor slip in transcription or in keying on their calculators leads to no marks being awarded because no working is shown.

It appeared that only a small minority of candidates may have been short of time. In general, these were weak candidates. For adequately prepared candidates, the paper seemed to have been an appropriate length.

Comments on specific questions

Question 1

(a)(i) With very few exceptions, *a* was associated with acceleration.

(ii) Many correctly associated a negative value with deceleration, decreasing velocity or acceleration in the opposite direction to that which was defined as positive. However, a significant number thought that the acceleration would be in the opposite direction to the direction of motion or that the speed would be decreasing. Neither of these suggestions is necessarily correct.

(b)(i) Most candidates related constant speed to equal distances covered in equal time intervals but many then failed to relate this fact to the diagram.

(ii) In **(i)** most candidates were able to read off the required distance and then add the distance travelled at constant speed in part **(ii)**. However, a significant minority calculated an average speed for the first 0.7 s and then applied this speed to the whole time of 1.1 s. Others assumed a constant acceleration, either *g* or one calculated for the first 0.7 s.

(c) Most candidates recognised that the sphere could be considered to be in free fall with acceleration *g*. However, many who correctly calculated the time then failed to determine the correct number of flashes. It was not uncommon to find that the distance was not converted to metres for the calculation using $g = 9.8\ \text{m s}^{-2}$.

Question 2

(a) Few candidates 'defined' mass as a measure of a body's resistance to change in velocity. Many defined, quite unacceptably, the mass as being the amount of substance in body. Weight was more successfully defined. Most did associate weight with the force exerted on a mass in a gravitational field, although explanations were frequently vague.

(b) Most candidates suggested examples where the local value of *g* would differ. Others cited examples where the body would be immersed in a different fluid or would be accelerated in a lift (elevator). A common error was to think that the weight would be different in a lift moving at constant speed.

Question 3

(a) Frequently, moment was defined as being the product of force and distance. This is indistinguishable from an equally vague definition of work done. Those who did make a reference to perpendicular distance often failed to define what is meant by perpendicular distance or confused the point of application of the force with the pivot point.

(b) The conditions for equilibrium were generally well known. A common mistake was to state that, for translational equilibrium, 'the sum of the upward forces must equal the sum of the downward forces', completely ignoring any horizontal forces.

(c)(i) Nearly half the candidates showed the forces in the wrong directions.

(ii) In general, the calculations were disappointing. Many candidates correctly calculated the moment of the force about the centre of the disc. However, they then failed to equate the torque provided by the strings to the moment of this force. In many answers there was frequent confusion of units and a failure to understand how to calculate the magnitude of one of the forces making up a couple.

Question 4

(a)(i) Most candidates correctly determined the amplitude and the wavelength, although a significant minority attempted to find the wavelength from the displacement - time graph. In 3 approximately one half of all candidates failed to convert milliseconds to seconds when finding the frequency. Calculation of the speed presented very few problems although answers were sometimes quite bizarre.

(ii) Some candidates drew a second wave on Fig. 4.1 rather than on Fig. 4.2. Others drew a separate diagram. It was very common to find that the wave drawn had double the frequency, rather than half the frequency of the original wave.

(b)(i) A surprisingly large number of candidates did not realise that the grating spacing is simply the reciprocal of the number of lines per unit length of the grating. Others were confused by the need to express the answer in micrometres.

(ii) It was pleasing to note that most candidates did use the grating formula $d\sin\theta = n\lambda$ although a significant number thought that *d* represented either the distance between the double slit and the screen or the number of lines per metre.

(iii) There was a significant number of attempts to solve this problem using a double slit formula. However, there were many clear correct solutions although there was some confusion as regards the use of sine or tangent.

Question 5

(a)(i) In most scripts, the direction was correct although some candidates would have been well advised to use a ruler.

(ii) The unit of electric field strength was given as N C^{-1}, rather than V m^{-1}. Consequently, the most common error was a failure to convert the unit of distance to the metre.

(b)(i) Many either correctly calculated the force on the electron and the work done by that force or used the product of charge and change in potential between the plates. Some made no attempt at this calculation or attempted to use the expression *mgh* with *g* being the acceleration of free fall.

(ii) There was a higher frequency of success in this calculation than in **(i)**. The most common error was a failure to take the square root in the final stage of the work. Consequently, candidates settled for an answer of the order of 10^{14} m s^{-1}, without any comment.

(c) There were very few correct sketches. The most frequent answer was a straight line. Candidates should realise that if the velocity increases at a constant rate, then the displacement will increase at an increasing rate, giving rise to a curve with a progressively decreasing gradient.

Question 6

(a) With few exceptions, the correct numbers were given.

(b)(i) When finding the mass of the nucleus, some candidates did not include the mass of the neutrons. Many of those who elected to use the Avogadro constant confused the gram-mole and the kilogram-mole.

(ii) As is often the case, a large number of candidates could not recall the formula for the volume of a sphere. Most of those who could find the volume of a sphere correctly calculated the density.

(c) Very few answers involved the relatively very high density of the nucleus and the smallness of the fraction of the volume of the atom occupied by the nucleus. Most answers were, quite wrongly, based on atomic structure and the spaces between atoms.

Question 7

(a) Most candidates correctly used the power and voltage ratings to show that the current is 5A and then calculated the resistance. A small number of answers involved assuming the current is 5A in order to calculate the resistance, then using this resistance value to show that the current is 5A.

(b) Most candidates answered correctly all three parts. However, some did misunderstand what is meant by 'potential difference across the cables'. Others failed to appreciate that the mains voltage must be the sum of the potential differences across the heater and the cables.

(c) Although there were many correct solutions, it was apparent that some candidates did not appreciate the situation. Some did not associate 1.2 kW with the power dissipated in the heater, often using the power dissipated in the cables. A significant number of answers gave efficiencies in excess of 100%.

Paper 9702/03

Practical Test

General comments

The overall standard of the work produced by the candidates was similar to last year. Disappointingly there were a number of candidates who found the paper quite difficult (scoring marks of less than ten), although it was pleasing to see many strong candidates scoring twenty-two plus. Most Centres had no difficulty with the apparatus requirements, and very little help was given by Supervisors to enable candidates to carry out the experiment. There was no evidence that candidates were short of time.

Comments on specific questions

Question 1

In this question candidates were required to investigate the oscillations of a pendulum with a stop.

Virtually all candidates were able to set up the apparatus without help and measure six sets of values of *d* and *t* as the position of the stop was changed. Most candidates were able to calculate the percentage uncertainty in the first value of *d* correctly, although a number of candidates were over-optimistic in the estimation of D*d*. It was expected that the uncertainty would be one or two millimetre (half a millimetre uncertainty at each end of the rule was felt to be the best achievable). Sometimes the calculation was not attempted by the weaker candidates.

Almost all candidates were able to measure the time for a suitable number of oscillations of the pendulum and calculate the period *T* for six different values of *d*. It was expected that the readings would be repeated and that there would be sufficient oscillations for a reasonable time interval to be measured (i.e. at least 20 s). A number of weaker candidates did not record the raw values of time. Most candidates calculated values of *d*/*T* correctly, although there were some candidates giving values of *T*/*d*. Sometimes candidates forgot to divide the raw values of *t* by the number of oscillations and recorded values of *d/t* instead of *d/T*.

Virtually all candidates presented the results in tabular form. Sometimes the units for *d/T* had been omitted. Raw values of *d* were sometimes given to the nearest centimetre instead of the nearest millimetre (it is expected that the values will be given to the nearest millimetre as a rule when a millimetre scale is being used to make the measurement).

Candidates were required to justify the number of significant figures which they had given for *d*/*T*. It was expected that candidates would simply relate the number of significant figures in *d* and *t* to the number of significant figures in *d*/*T*. The number of significant figures in *d* was often less than the number of significant figures in *t* (usually three and four respectively). An answer such as, '*d* is given to three significant figures and *t* is given to four significant figures. Therefore I have given the values of *d*/*T* to three significant figures', would gain full credit. Candidates who made reference to *d* and *T* instead of *d* and *t* were given partial credit. It is important that candidates realise that the number of significant figures in a calculated quantity is related to the number of significant figures in the *raw* data.

Candidates were required to plot a graph of *T* against *d/T*. Common errors made by the weaker candidates included poor choice of scales (i.e. where the plotted points occupied less than half the graph grid in both the *x* and *y* directions) or where the scales were awkward (e.g. one large square on the grid corresponding to three units). Candidates should be encouraged to use simple scales such that the points fill most of the graph grid. Points were usually plotted correctly. When plotting errors occurred it was usually because awkward scales had been chosen. It is expected that candidates will plot six points since six observations have been made. Candidates who did not plot all their observations were penalised. Most of the better candidates were able to determine a value for the gradient of the line correctly. When the mark was not awarded it was usually because the triangle that had been used was too small or an error had been made in the read-offs. Sometimes the negative sign had been omitted. The *y*-intercept was usually read correctly from the graph or found using the co-ordinates of a point on the line and the equation of a straight line. A number of weaker candidates incorrectly read the intercept from a line which was not the *y*-axis (i.e. they had used a false origin).

Two marks were 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 both marks if the scatter of points about the line of best fit was small.

The analysis section continues to differentiate well between candidates. Weaker candidates often did not attempt this section. The better candidates were able to equate $\frac{-\pi^2}{g}$ with the gradient of the graph and T_o with the *y*-intercept. A number of the weaker candidates did not use the gradient and *y*-intercept values and attempted to calculate values for *g* and T_o by substituting table values into the given equation. This was not accepted. Candidates who had done the experiment carefully and managed to obtain a value for *g* in the range 9.3 m s^{-2} to 10.3 m s^{-2} were given further credit. The better candidates usually scored full marks in this section.

In **(h)** candidates were asked to suggest an improvement to their experiment if they had to repeat it. Many candidates made suggestions that were not credited because they should have been done when the experiment was performed (e.g. repeat readings). Other suggestions were unworkable or not relevant (e.g. 'do the experiment in a vacuum' or 'use a heavier bob'). It was expected that candidates would suggest timing a greater number of oscillations, or use a thinner stop or knife edge to improve the measurement of *d*.

Paper 9702/04

Core

General comments

The paper provided a good spread of marks. Although there were parts of most questions that were demanding, there were other parts that could be answered by weaker candidates. As is usually the case, numerical parts of questions were, in general, better answered than the descriptive sections.

Where part of a question involves a simple calculation, there is a tendency amongst some candidates to give an answer with no explanation. This practice should be discouraged since an incorrect answer would mean that no marks could be awarded for the approach to the problem.

The majority of candidates appeared to have sufficient time to complete the paper. Some weaker candidates did leave parts of questions unanswered, but this could not necessarily be attributed to a shortage of time.

Comments on specific questions

Question 1

(a)(i) The majority of diagrams were acceptable sketches. However, a surprisingly large number of diagrams showed the field in the wrong direction.

(ii) It was expected that candidates would state that either there is no difference or that there would be a greater density of lines at the surface of the smaller sphere. However, most stated that there would be more lines.

(b)(i) This calculation presented very few problems, apart from a failure to convert the Earth's radius from kilometres to metres.

(ii) Again, the major problem was units, rather than the physics of the situation.

(iii) The calculation of the difference produced some bizarre results. Candidates should realise that the force acting on a 1 kg mass on the Earth's surface could not possibly be 10^{13} N.

(c) There were some good, well-argued answers based on the numerical answer to **(b)(iii)**. However, weaker candidates frequently quoted '9.8 m s^{-2}', without any meaningful comment.

Question 2

(a)(i) There were very few errors here but the most common was to identify either *a* or *x* as being the amplitude.

(ii) This was answered satisfactorily by most candidates. However, a significant minority thought, quite wrongly, that the acceleration would always be in the opposite direction to the velocity.

(b)(i) This part of the question was answered badly by most candidates. Rather than give the forces in the springs as $k(e + x)$ and $k(e - x)$, they quoted kx and $-kx$. Others assumed a spring constant of $2k$ and an extension of x or an extension of $2x$ with a spring constant k.

(ii) The derivation presented very few problems. However, it was common to find that there was no explanation for the appearance of the minus sign in the expression.

(iii) Apart from the usual confusion with units, the calculation caused very few problems.

(c) There were some good suggestions based on the concept that the atoms vibrate and are held in their mean positions by attractive forces. Very few suggested either that there would be more than two forces acting on the atom in a crystal or that the oscillations would be in three dimensions.

Question 3

(a) It was pleasing to note that very few candidates failed to convert the temperatures to kelvin temperatures. Rather than use proportions, some solutions involved finding the number of moles of gas in the container.

(b)(i) In many areas of physics, repeated examination of a topic leads to an improvement in overall performance of candidates. This is not the case here. All too frequently, candidates identify change in internal energy, heating and working, but then fail to discuss the direction in which all three are changing.

(ii) The failure to identify the direction of the changes became apparent in this part of the question. Candidates were expected to argue that the internal energy would increase and that, for an ideal gas, this increase would be seen as an increase in the mean kinetic energy of the atoms. Hence, the temperature would rise. It is very disappointing to note that there are candidates who are under the impression that increasing the pressure causes more collisions with the walls and consequently more heat is produced as a result of the collisions, thus increasing the temperature.

Question 4

(a) There was a number of interesting suggestions, but most did state that a single diode should be used. However, many failed to mention where the diode should be connected into the circuit.

(b)(i) Although most candidates did read off a value for the mean p.d. from the graph, a significant proportion gave 4.24 V ($6/\sqrt{2}$) as the answer. The calculations of the current presented very few problems and most were able to correctly identify the time for the discharge.

(ii) The first part was completed successfully by most candidates. However, in the second part, very few scored full marks. With few exceptions, candidates failed to realise that, because they had calculated the change in the charge, then they needed to substitute the change in potential difference into the formula for capacitance.

(c) Diagrams were, in general, very poor and consequently were not given credit. The most common errors were either to show the new waveform passing through the peaks or to have a line that showed a decrease, then an increase in potential during the discharge period.

Question 5

(a) Definitions were, in general, poor. Many candidates misread the question and attempted to define magnetic flux density, rather than the tesla. Of those who did succeed in referring to the magnitude of the force as being 1 N m^{-1} on a conductor carrying a current of 1 A when placed in the uniform field of 1 T, very few made any mention of the angle between the field and the conductor.

(b)(i) Apart from those who thought that flux is given by the ratio *B/A*, this calculation caused few problems. Most realised that the area must be in m^2, although some had difficulty with the conversion.

(ii) It was surprising that many did not realise that the flux change would be numerically equal to the answer calculated in **(i)**. More able candidates completed the calculations with apparent ease but this proved, as usual, to be a difficult topic for weaker candidates. Many of these candidates did not even attempt the calculations.

(iii) This was poorly answered by most candidates. The most common answer was either that there would be a current because, by Lenz's law, there must be a current to oppose the change or that there would be no current because the induced e.m.f. is too small. Candidates were not expected to analyse whether there would be an induced e.m.f. in the other sides of the frame. It was sufficient to realise that the aluminium frame formed a complete loop in which a current could be found.

Question 6

(a) Some candidates referred to a photon as being a particle. However, most did suggest that it is a 'packet' or 'quantum' of energy. Very few went on to give the expression $E = hf$ for this quantum of energy.

(b) There were some good answers here but many candidates either repeated themselves or could not give three different observations. A common error was to state that there is a threshold frequency, without relating threshold frequency to what is observed. Credit was lost frequently because candidates referred either to kinetic energy rather than to maximum kinetic energy of the emitted electrons or to number of electrons emitted rather than to the rate of emission.

(c) Candidates need to be made aware of what is meant by 'state and explain'. All too frequently, statements were made without any justification being provided.

(i) The majority of candidates did realise that the maximum kinetic energy of the electrons would be unchanged and that the rate of emission would be halved. However, these facts were frequently expressed poorly and explanation was inadequate.

(ii) Most candidates did state that the maximum kinetic energy would be greater. However, there was a widespread misconception that the arrival rate of photons would be unchanged because the intensity is unchanged. If each photon 'carries' more energy, then the rate of arrival must be lower in order to maintain constant intensity. Thus, the rate of emission of photoelectrons would be reduced.

Paper 9702/05
Practical 2

General comments

The general standard of the work by candidates was very similar to last year, and the paper produced a wide spread of marks. **Question 1** proved to be accessible to most candidates. However, as in previous years, many of the weaker candidates found the design question very difficult, and a large number of scripts were seen where the marks for this question were very low. It may be that candidates are spending too long on **Question 1** and not enough time on **Question 2**.

A number of Centres had difficulty in obtaining the diode that had been specified in **Question 1** (IN4001). It is perfectly acceptable for Centres to use a similar diode *provided* that the experiment performs as intended (i.e. the graph of ln (I/A) against *V* gives a straight line with a positive gradient which does not pass through the origin) *and* that the changes are detailed in the Supervisor's Report. Candidates will not be disadvantaged if this is done.

Comments on specific questions

Question 1

In this question candidates were required to investigate the characteristics of a diode when the temperature of the diode was close to zero degrees Celsius.

The majority of candidates were able to set up the circuit correctly and take six sets of readings for *V* and I. There were a few reported cases of assistance given to candidates by Supervisors in the construction of the circuit. Some of the weaker candidates had to have the circuits assembled for them by Supervisors. Values of ln (I/A) were usually calculated correctly, although a number of weaker candidates became confused between milliamperes and amperes and recorded values of ln (I/mA) which led to a power of ten error in later calculations. A current range was not specified in the question paper, and most candidates took values of currents that were well separated from each other. The current limiting resistor prevented candidates from using currents that were too large. Some Centres were concerned that candidates may be penalised by using a current range that was too large. There were no marks in the mark scheme for any particular range of current.

Candidates were instructed to maintain the temperature of the ice/water mixture close to zero degrees for the duration of the experiment. This should have been easily achievable with crushed ice, however some candidates recorded temperatures that were considered to be too high (i.e. three degrees Celsius or greater).

Most candidates presented the results in tabular form with correct column headings. Values of I and *V* were usually given to an appropriate degree of precision.

Graphical work was generally done quite well by the majority of candidates, although there were a number of poor scales (e.g. eight small squares on the graph grid corresponding to a current of ten milliampere). Lines of best fit were drawn reasonably well. In the calculation of the gradient candidates sometimes used points on the line that were too close together, resulting in inaccurate values for D*x* and D*y*. it is expected that the hypotenuse of the triangle used will be greater than half the length of the line that has been drawn. The calculation to find the *y*-intercept was usually done correctly, although a number of weaker candidates attempted to read the *y*-intercept from a line where $V \neq 0$.

The analysis section proved to be quite challenging, and was more difficult than last year. Many of the weaker candidates were unable to express the given equation in logarithmic form. Some candidates attempted to calculate values for *e* and I_o by substituting values into the equation. This was not credited since the question requires candidates to use their answers from **(e)(ii)**. Other candidates confused naperian e with the electronic charge *e*.

A mark was awarded for the candidates who gave *e* to a sensible number of significant figures (two or three). This mark was given to most candidates who managed to obtain a value for *e*. Candidates who had performed the experiment properly and done the calculation correctly were able to score a further mark by obtaining a value for *e* which was the right order of magnitude (10^{-19} C or 10^{-20} C). A number of candidates did not include the units of *e* or I_o with their answers.

In part **(g)** many of the more able candidates were able to perform the calculation to find the current in the diode. Sometimes an incorrect temperature was used (273 K instead of 373 K), or candidates attempted to use the gradient from **(e) (ii)**, which resulted in an incorrect answer (as the temperature was again incorrect).

Question 2

In this question candidates were required to design a laboratory experiment to investigate how the acceleration of a system of two connected particles varies with the mass of one of the particles.

Answers to this question were generally quite disappointing. It was clear that a significant number of candidates had never measured an acceleration, and numerous accounts were given where the whole ‘experiment’ had been done theoretically (usually by applying Newton’s second law to each particle and solving the resulting equations simultaneously). This is not a laboratory experiment, and usually resulted in a zero score. It is expected that an *experiment* will be described. Generally the answers given by many candidates were too superficial and lacked detail.

A number of experiments described were not related to the question that had been asked. It was quite common to see a falling mass attached to a trolley moving on a horizontal surface. Some of the weaker candidates attempted to time oscillations of mass B.

Very few candidates made any mention of how the mass B would be measured (i.e. using a top pan balance).

A large number of responses were seen where the time taken for mass A to fall through a measured distance was recorded. The use of a stopwatch to find times was common with very few candidates expressing any appreciation of the limitations offered by this method. Speed = distance/time and acceleration = speed/time were often quoted with little extra detail. This incorrect method (since the speed measured was an average speed) did not score well. Better answers included the use of two sets of light gates to measure the speed at different points during the fall.

Few candidates made any mention of safety precautions, even though this had been asked for in the question. It was expected that candidates would suggest placing a bucket of sand below the falling mass or the use of goggles in case the wire breaks and whiplash occurs. Many vague answers were seen, such as 'care must be taken when carrying out the experiment' or 'I would do it safely' with no further detail of what would actually be done.

It was possible for candidates to be given credit for any mention of 'good design features'. The better candidates who gave detailed answers scored quite well here. Some of the responses which were given credit are as follows:

- Use a large distance to reduce the percentage uncertainty,
- Method of supporting the pulley,
- Friction in the pulley may be a problem,
- Use a graphical method to find the acceleration,
- Detail about the timing circuit (if an electrical method employed).

Paper 9702/06

Options

General comments

The great majority of candidates attempted Options F and P. They appeared to have no difficulty in completing their answers in the available time.

The general level of performance was disappointing and was below that expected. Above average candidates did not have a sound knowledge of the bookwork and they seemed unable to apply basic principles to unfamiliar situations. The impression gained by Examiners was that the candidates had not prepared sufficiently well for the examination.

In a number of Centres, it was clear that candidates had been given free choice as to which Options to study. In other Centres no choice had been given. Performance of candidates was usually lower where candidates had not been directed as to their choice of Options.

Comments on specific questions

Option A

Astrophysics and Cosmology

Question 1

(a) Most candidates realised that the galaxy is distant and that the light intensity reaching Earth would be low. Some mentioned light pollution or atmospheric absorption. However, many did not appear to consider the mark allocation or the number of answer lines and thus wrote insufficient to have any possibility of scoring maximum marks.

(b) The calculation was very disappointing. Most candidates merely attempted to convert 0.69 Mpc to a distance in light-years. Many did not seem to realise that the length of the arc associated with an angle of 1 arc-second at a distance of 0.69 Mpc would, by definition, be 6.9×10^5 AU.

Question 2

(a) Most answers included a statement that the night sky would be as bright as day. However, the reason for this was, in general, not given.

(b) Many stated that the Universe could not be infinite and static. However, they thought that the Olber paradox proves the existence of the Big Bang.

Question 3

(a)(i) In most answers, the question was paraphrased without any additional information being given. The fact that this radiation is electromagnetic and characteristic of a black body at 3 K was not appreciated.

(ii) Some candidates did state that it indicated a cooling Universe. However, the majority had little idea as to the nature or significance of background radiation.

(b) Very few answers indicated that looking at distant galaxies is 'looking back' in time and that the radiation from the distant galaxy provides evidence for higher temperatures in the past. Rather, the suggestions were based on something happening at the present time such as 'burning of the carbon' of 'fission' or 'fusion' producing extra energy.

Option F

The Physics of Fluids

Question 4

(a) There were some good clear explanations. Others found some difficulty in expressing themselves and Examiners were left wondering why the candidates did not draw a sketch to illustrate their explanations. In some answers it was not made clear that the metacentre is a point.

(b) With few exceptions, explanations were poor. Some candidates did not even mention that air replaces water in ballast tanks when the submarine surfaces. In the vast majority of answers, only movement of the centre of buoyancy was considered. Candidates should realise that both the centre of mass and the centre of buoyancy will move and that stability is concerned with the separation of these two centres.

Question 5

(a) There were some good reasoned statements as to why the pressure at A is the higher. However, a significant minority stated that the pressure at B would be higher because the force pushing along the fluid would act over a smaller area.

(b) Most candidates could arrive at the correct conclusion. However, explanation in many answers was suspect, particularly as regards the formula for area of cross-section. Candidates should be encouraged to give clear explanations of their working, not only in derivations but also in calculations.

(c) Weaker candidates were unable to manipulate successfully the Bernoulli equation. Others paid little regard for the signs in the equation. Of those who did substitute into the equation, many then stated that $(9v)^2 - v^2 = 8v^2$.

Question 6

(a)(i) Surprisingly, many candidates merely wrote down U or some other symbol. Of those who did give an expression, it was common to find that either the density was not specified or the density of the sphere was used.

(ii) It was acceptable to include or to exclude the term involving drag. However, as in **(i)**, there were many answers where single symbols were used for each term.

(b) A number of candidates who were unable to give the expressions in **(a)** were able to derive the correct expression for v_t. Disappointingly, those who did derive the full expression frequently did not discuss which terms are constant and make up the constant *k*. Good attempts at this question were in a minority. Many candidates had little or no idea as to what is involved.

(c)(i) There were some good answers to this part of the question, often aided by small sketches. Some candidates quite clearly had the correct ideas but had difficulty expressing themselves. The drawing of small sketches should be encouraged.

(ii) The vast majority of answers mentioned, quite wrongly, that the tube must be wide to prevent the sphere hitting the wall of the tube. Very few referred to increased drag as the flow of oil around the sphere would be restricted. Pleasingly, some did mention that the Stokes' formula applies to an infinite medium.

Option M

Medical Physics

Question 7

Answers tended to be sketchy, with most candidates scoring only two or three marks. Some were unaware of the fact that a non-uniform magnetic field is superimposed on a large uniform magnetic field. Others made no reference to hydrogen atoms. Many referred to an r.f. signal being detected and processed, without any mention of an r.f. input pulse.

Question 8

(a)(i) This calculation was completed successfully by most candidates.

(ii) Weaker candidates did not seem to realise that they had to decide on the least distance of distinct vision. Others substituted a number into the equation without explanation.

(b)(i) Those who had produced answers in **(a)** usually gave the correct change in the power, although a significant minority were unconcerned with the sign of the change.

(ii) The calculation itself presented few problems. However, with many weaker candidates, the significance of the sign in **(b)(i)** was not apparent.

Question 9

(a) Although there were some full and correct answers here, the majority were incomplete, with one or more of the relevant values missing.

(b) This was not well drawn. Most candidates realised that the line should be above the given line. However, this new line was frequently straight or cut through the given line.

Option P

Environmental Physics

Question 10

(a) Statements were usually quite adequate. However, a minority explained what is meant by a *fossil* fuel.

(b) Most candidates could make two sensible suggestions. Surprisingly, very few realised that fossil fuels are a feedstock to the chemical industry.

Question 11

(a) There were many descriptions where it was not possible to distinguish between a tidal barrage scheme and a pumped-storage scheme. Very few clearly indicated the purpose of the barrage. Furthermore, the times, relative to the tides, at which water is stored and electrical energy is generated were not made clear. It was common to find that it was thought that the turbine acts as the generator.

(b) Rather than working from first principles, many candidates had memorised a formula for the energy available. This formula was not entirely applicable in that it contained the term $(R/2)^2$, rather than $\frac{1}{2}R^2$. In some answers, the value of g was taken (quite wrongly) as 10 m s^{-2}. Frequently, these candidates then gave their final answer to three of more significant figures. Candidates should use the data provided.

(c) Most candidates could make at least one sensible suggestion. Short statements, such as 'damage to marine life' were not accepted. Others thought that changes in water level would be a factor, forgetting that the region would be tidal, regardless of the barrage.

Question 12

(a) There were many correct responses here although it was obvious that a minority of candidates had no concept of the operation of a petrol engine.

(b)(i) Very few candidates scored this mark. It was not understood that ignition occurs at a point in the cycle (approximately at the end of the compression stroke). Most thought that ignition occurs throughout the power stroke.

(ii) Nearly all answers mentioned the exhaust stroke. However, with few exceptions, there was no reference to the exhaust gases leaving the cylinder as the exhaust valve opens. The exhaust gases are removed in two stages.

(c) There were some very sensible suggestions such as better mixing of fuel and air, increased area for combustion and faster combustion. There were also some very imaginative alternatives such as 'liquid would not go into the cylinder' and 'liquid would explode'.

Option T

Telecommunications

Question 13

(a) Many candidates lost this easy mark through carelessness. It is expected that, at A Level, angle of incidence should be equal (by eye) to angle of reflection.

(b) There were very few correct answers here. Making the fibre as narrow as possible eliminates possible path differences (hence less multipath dispersion) it also makes the fibre easier to store and to handle. It was thought by many that 'it would assist with total internal reflection'.

(c) This part was answered well with some candidates giving more than three advantages. Most commonly, they referred to greater bandwidth, increased security and size and weight.

Question 14

(a) Better candidates had little difficulty with the explanation. However, there were numerous answers where it appeared as if the candidate had little real concept of modulation.

(b) The sketches were disappointing. Where the graph was recognisable, most had drawn lines appropriate to the transmission of a spectrum of frequencies, rather than a single frequency.

(c) Most answers were correct. Some candidates did confuse bandwidth with carrier frequency and consequently gave the answer as 75 kHz. Surprisingly few gave the answer as 5 kHz.

Question 15

(a) In general, candidates were able to explain the meaning of attenuation as a loss of power or energy. However, they were far less sure about noise and many did not attempt an answer. They were expected to know that noise may be considered to be unwanted energy/power that is random.

(b) Calculations of this type give rise to three categories of answer. Some candidates have no real idea of the concepts involved. Others can quote the relevant formula and make sensible substitutions but are unable to do the subsequent manipulations. Then there are others who show total competence in what they are doing. It was pleasing to note that there were candidates who clearly understood what they were doing and that there were very few who did not know how to start the task.

(c) Candidates should be advised to determine the total attenuation before calculating the length. It was disappointing to find numerous scripts where the calculation in **(b)** had been completed without any problems but then, in **(c)**, the calculation failed through attempting to carry out both stages in one.

Paper 9702/08

Practical Test (Mauritius Only)

General comments

The standard of the work done by candidates was very similar to last year and the paper produced quite a wide spread of marks. It was pleasing to see a number of the most able candidates achieving the paper maximum. There were few very poor scripts (where candidates had scored marks below 10).

Very little help was given to candidates by Supervisors. There was no evidence that candidates were short of time.

Centres appeared to have no difficulty in obtaining the required apparatus for the experiment in **Question 1**, and generally the experiment performed as intended.

Comments on specific questions

Question 1

Candidates were required to investigate the oscillations of a loaded metre rule.

Most candidates took six sets of readings of d and t 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). Values of d were usually suitably spaced (i.e. > 5 cm between the values). Virtually all candidates calculated d^2 and T^2 correctly. Usually the values were given to an appropriate number of significant figures.

Candidates were asked to justify the number of significant figures which they had given for d^2. Most candidates were able to relate the number of significant figures in d to the number in d^2 (as required), although a number of the weaker candidates made vague references to 'raw data' rather than specifically referring to d. Other candidates were confused between significant figures and decimal places.

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 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.

Candidates were required to plot a graph of T^2 against d^2. Generally this was done quite well, apart from a few very weak candidates who had one large square representing each value for d^2 (i.e. a scale of 1600, 2500, 3600 etc.). There were few awkward scales (e.g. 3:10 or 6:10), although a number of candidates drifted the '8100' or '0.81' value into the margin area and were penalised. It is expected that all graphical work will be done on the graph grid. 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 that 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 $\Delta \tilde{y}\Delta x$). Most candidates had been well-trained in the use of $y = mx + c$ when calculating the *y*-intercept and few lost the mark as a result of having a false origin.

In the analysis section most candidates were able to equate the gradient with *A* and the *y*-intercept with *B*. Many of the weaker candidates however found the algebra difficult when finding values for *k* and *l*. Candidates who did not use their gradient and *y*-intercept values in the working were unable to score these analysis marks. Many of these candidates substituted values from the table into the given equation and attempted to solve the resulting simultaneous equations. This was not credited. Only the most able candidates were able to give the correct units for *k* and *l*.

Question 2

In this data analysis exercise candidates were given data relating to a thermocouple. Most candidates were able to calculate values of E/θ correctly and explain why plotting the suggested graph would confirm the relationship. It was expected that a linear form of the equation would be given with some explanation. A number of weaker candidates suggested that E/θ was directly proportional to θ, which was not accepted. Other candidates gave vague statements such as 'E/θ decreases as θ increases', which was also not accepted.

Most candidates were able to plot the graph of E/θ against θ and obtain a value for the gradient in the range -4.9×10^{-4} to -5.1×10^{-4}. Some candidates plotted points incorrectly, particularly for 80°C and 120°C. A few candidates omitted the negative sign with the gradient value. The *y*-intercept was usually given correctly as 0.20.

In part **(e)** most candidates identified *b* with the gradient and *a* with the *y*-intercept, although a number of candidates had the values reversed. Disappointingly large numbers of candidates either omitted units with the values or gave incorrect units.

In part **(f)** many candidates were not able to identify the anomalous reading. Few gained a 'thermal contact' mark, but there were some sensible suggestions relating to temperature not being 250 degrees at the moment of reading the millivoltmeter. 'Sudden change' arguments were rare and not well-made. Too many candidates failed to note that 'the cold junction was *maintained* at 0°C' and that 'the millivoltmeter was read correctly throughout' and consequently gave invalid answers.

The more able candidates were able to calculate the e.m.f. in part **(g)** without difficultly. A number of candidates made sign errors in the calculation. The correct value for the e.m.f. should be –160 mV, but sign errors often led to an incorrect value of 480 mV.

In the final section it was hoped that candidates would realise that the thermocouple might melt making the e.m.f. impossible to measure. However, a number of candidates thought that the reading could not be obtained because 'the value was negative' or 'the resistance would be too high'.