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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
Multiple Choice

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

General comments

The Paper provided good syllabus coverage and proved to be satisfactory, with good discrimination and a relatively high overall facility. The mean mark of 25.6 was a little down on last year as was the standard deviation of 6.4. All of the questions again gave a positive discrimination, although in the case of **Question 20** only just. Further comments on this question will follow. Statistics show that the vast majority of candidates were well prepared for the test and knew the fundamental facts of most of the syllabus items. With a multiple choice test it is difficult to ascertain how the timing of the Paper seemed to the candidates but there was no direct evidence of candidates being unable to complete the Paper in the allotted time.

The questions which generally did not cause candidates any problems were **Questions 1**, **2**, **4**, **12**, **14**, **24**, **26**, **31**, **33**, **37** and **38**, these were straightforward and the marks were correspondingly high. **Questions 5**, **11**, **17**, **20**, **21**, **22**, **30** and **35** were answered poorly.

Comments on specific questions

Question 5

A and **B** were common responses. Perhaps candidates did not see the significance of the fact that 3% of 330 is 10 but just tried to give rounding to 3 or 4 significant figures.

Question 11

C was the most common response, presumably because they forgot about the support force exerted on the wheel and knew that the wheel exerts a force backwards on the road when accelerating. Only 21% of candidates realised that on a front wheel drive car the force on the front wheel during acceleration must be upwards and forwards.

Question 17

D (*Wr*) was too popular an answer. This answer comes from those candidates who think that work = force x distance, without any reference to the direction of the force.

Question 20

This question had only a very small positive discrimination. Even many good candidates tried using 90% of atmospheric pressure and had the answer **B**. This illustrates the problem with algebraic answers. Perhaps if they had realised that their answer was giving a straw of length 9 metres they might have re-checked their answer.

Question 21

33% of candidates thought that the ultimate tensile stress was the stress at the elastic limit.

Question 22

Quite a tricky question which needs careful working, done on paper and not mentally. Only 36% got this correct.

Question 30

This straightforward question proved to be the most difficult on the Paper. Only 11% gave the correct response of **C**. 77% just subtracted the two currents instead of finding the mean current of 60 mA.

Question 35

Probably candidates knew that the field between the plates is uniform but find it difficult to relate this to a horizontal graph. 53% were thinking of potential fall so gave either **A** or **B**. 41% correctly gave **C**.

Question 40

The unfamiliar nature of this question did not put candidates off. 60% of them managed to get **D** as the correct response.

Paper 9702/02

Structured Questions

General comments

The Paper offered candidates from a wide range of abilities the opportunity to demonstrate their understanding of Physics. In general, numerical questions were answered well where only the use of standard formulae was required. Where a greater depth of understanding was required, the standard of answers varied widely.

Although some candidates express themselves clearly and gave adequate explanation of their reasoning, many others make little attempt to develop a logical argument, in words or in figures.

There is an increasing tendency amongst candidates to disregard the number of significant figures in answers. Strings of eight or more digits are not uncommon and these are copied from one section of a question to another. At the very least, this wastes time but often, copying errors occur. Candidates should be encouraged to use index notation.

The vast majority of candidates completed their answers to the Paper and there was no real evidence that the Paper was too long.

Comments on specific questions

Question 1

This question was a good discriminator.

Most candidates gave the correct unit for density. The most common answer for s^{-1} was frequency. However, some did write either 'rate' or '1/time'.

The acceptable unit of electric field strength is $V\ m^{-1}$ or $N\ C^{-1}$. Some candidates lost their way when attempting to convert the unit into SI base units. The majority correctly identified $kg\ m\ s^{-1}$ as the unit of momentum or impulse. Amongst weaker candidates, 'force' was a common answer.

Question 2

(a) In general, 'displacement' was poorly defined. Many merely stated that it is the distance between two points. Of those who did refer to a specified direction, most did not state that the distance is measured from a (fixed) point.

Most did reveal that they had some understanding of displacement in that they stated that the car must return to its starting point.

(b)(i) The four calculations in this part were generally done well. Some did nullify their attempted use of the equations of motion by using inappropriate components of distance and/or velocity.

(ii) Many candidates were able to give an appropriate equation for the output power. However, it was not uncommon to find that either only the change in kinetic energy or only the change in potential energy or the difference between these energies was used. A significant number did calculate the product of the resultant force required to produce the acceleration up the slope and the final velocity. This approach ignored the weight of the car.

(iii) Most candidates did identify resistive forces such as friction or drag but often failed to point out that it is the work done in overcoming these forces that gives rise to the need for increased output power from the engine.

Question 3

(a)(i) With very few exceptions, candidates recognised that the graph is for a ductile material.

(ii) Most did mark the point L at the end of the straight-line portion of the graph. Although most did associate the spring constant with the gradient of the graph, they frequently failed to state explicitly that it is the inverse of the gradient of the straight-line region.

(b) Those candidates who realised that they needed to find the length of that part of the circumference of the pulley that subtends an angle of 6.5° at the centre had little difficulty with the derivation. A significant number of candidates did not attempt an answer.

The three calculations presented very few problems for those candidates who knew the relevant formulae. The most common error was confusion over units, though some did confuse mass and weight when calculating the stress. Most candidates correctly checked that the elastic limit had not been exceeded by removing the additional load and checking that the wire had returned to its original length.

Question 4

(a) It was expected that the general conditions for interference would be given. That is, the waves should both be of the same type, they should be unpolarised or polarised in the same direction and they should meet at a point. However, most chose to give the conditions for an interference pattern to be visible. Some credit was given for this.

(b)(i) Very few candidates could give an appropriate separation. Many were of the order of the wavelength of light or the screen-slit separation. However, most answers were correct for the expression relating λ, a, D and x.

(ii) Most candidates scored more than half of the available marks for this part of the question. Despite being given some numerical changes, some candidates answered in a purely qualitative manner. The most common error was in the maximum brightness when the wavelength is increased. Although most realised that the fringes would broaden, they did not relate this broadening to the re-distribution of energy and the consequent decrease in intensity.

Question 5

(a) It was pleasing to note that very few candidates used a gradient when attempting to calculate either the resistance or the change in resistance. A minority did find the ratio I/V but the usual error was a failure to recognise that the current is in milliamps, not amps.

(b)(i) Although most candidates did draw a straight line through the origin, a surprisingly large proportion did not have the correct gradient.

(ii) Answers to this part of the question were very disappointing and only the most able candidates were able to arrive at the correct answer. In many attempts, different currents were used when calculating the potential difference across the lamp and across R. Many others equated the potential difference across R to the e.m.f. of the battery.

Question 6

(a) Many wrongly quoted the random variation of count rate as evidence of spontaneity whilst others quoted it as evidence for both randomness and spontaneity. There were very few clear answers where the similarity of the underlying exponential decrease in the two cases was identified as evidence of spontaneity.

(b) Both parts were answered correctly by the majority of candidates.

Paper 9702/03
Practical 1

General comments

The standard of the work produced by the candidates was generally good. It was pleasing to see fewer low scores (< 12) than in past years and there were quite a lot of strong candidates scoring 20+. 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 how the period of oscillation of a bent metal wire varies with the angle between the bent parts of the wire.

Most candidates were able to bend the wire and measure the angle θ between the straight parts of the wire, although many of the weaker candidates had difficulty with the percentage uncertainty in the value. Sometimes the calculation was not attempted. The most common error was to give $\Delta\theta = 0.5°$. This value was felt to be too low as it was difficult to place the protractor in the correct position when measuring the angle.

Almost all candidates were able to measure the time for a suitable number of oscillations of the wire and calculate the period T for six different values of θ. It was expected that the readings would be repeated and that there would be sensible intervals (at least ten degrees) between each value of θ. A number of weaker candidates did not record the raw values of time and therefore the values of T^{-4} could not be checked. Sometimes candidates forgot to divide the raw values of t by the number of oscillations and recorded values of t^{-4} instead of T^{-4}.

Virtually all candidates presented the results in tabular form, although it was common to see the units for T^{-4} omitted, or given as s instead of s^{-4}. Raw values of θ were sometimes given to an unreasonable degree of precision (i.e. to one or two decimal places).

Candidates were required to justify the number of significant figures which they had given for cos θ. It was expected that candidates would simply relate the number of significant figures which they had given for θ to the number of significant figures that they had given for cos θ. Answers which made reference to decimal places or 'raw data' did not score here. Some candidates appeared not to understand the question and just wrote 'I have given cos θ to three significant figures' without stating *why* they had given the value to three significant figures. An answer such as 'I have given cos θ to three significant figures because the raw values of θ are given to three significant figures' would have been given full credit.

Candidates were required to plot a graph of T^{-4} against cos θ. 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). 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. The y-intercept was usually read correctly from the graph.

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 analysis section continues to differentiate well between candidates. Weaker candidates often do not attempt this section. The better candidates were able to equate A with the gradient of the graph and B with the y-intercept although many did not give the correct unit of s^{-4} their values.

In **(g)** candidates were given the mathematical expression for A and were required to use it to obtain a value for the acceleration of free fall. This required candidates to measure the length L of the wire and substitute it into the given expression. It was expected that the value of L would be 40 cm $\pm$ 2 cm. Credit was given for a correct method of working which led to a value of g in the range 9.0 m s^{-2} to 11.0 m s^{-2}. The weaker candidates who lost themselves in the algebra and just quoted a value of 9.81 m s^{-2} were not given credit in this section. A sensible number of significant figures (two or three) was expected in the final value of g. Candidates who wrote down a value straight from the calculator to many decimal places were penalised here. An appropriate unit was expected with the answer. It was pleasing to see the more able candidates scoring full marks in the analysis section.

Paper 9702/04

Core

General comments

The Paper gave ample opportunity for candidates to demonstrate their understanding of Physics. In general, it was felt that perhaps the Paper was a *little* more demanding than in the corresponding session last year. However, there were parts of questions that required little more than a good knowledge of the bookwork.

The use of an excessive number of significant figures is becoming more common. At best, this is a waste of time but frequently it leads to transcription errors. Candidates should be encouraged to use index notation with an appropriate number of significant figures.

There was a small minority of candidates that did not complete the final question. However, it appears that, in the vast majority of cases, there was sufficient time to complete the Paper.

Comments on specific questions

Question 1

(a) Most candidates gave a satisfactory definition. A common error was a failure to mention that unit mass is involved.

(b) Very few scored full marks here. Most candidates stated that the potential at infinity is defined as being zero. Others also stated that the forces are always attractive. What was omitted was a clear statement that work is done *on* the mass when moving it to infinity.

(c)(i) Although the relevant formula for gravitational potential was widely known, incorrect substitution was very common. Either candidates calculated only the potential at the Earth's surface or only the potential at maximum altitude. Furthermore, many omitted to use distance in metres.

(ii) For some candidates, the question became one on circular motion. However, many did equate kinetic energy to change in gravitational potential energy (as calculated from **(i)**), but explanation was frequently lacking. A significant minority substituted into a stated equation for escape speed.

(d) Although most answers involved constant acceleration, a significant minority was based on the assumption that the value of *g* would not be equal to 9.81 m s^{-2}.

Question 2

(a) It appeared as if there was an element of guesswork amongst weaker candidates but the more able appeared to have little difficulty in answering correctly.

(b) There were extremely few correct answers to this problem. Only a small number of candidates attempted to write down a word equation that equated those changes where thermal energy is gained to those where it is lost. The general standard of explanation was so poor that it was difficult to award marks even for the basic equations $\Delta Q = mc\Delta\theta$ and $\Delta Q = mL$.

Candidates do need to gain experience of calculations involving thermal energy exchanges.

(c) The majority of suggestions were sensible, the most common being the thermocouple thermometer. A number of suggestions included the clinical thermometer and an alcohol-in-glass thermometer.

Question 3

(a) Most answers were based on the concept of resonance. The most frequent problem was a failure to make it clear that it is the natural frequency of the plate/spring that is of importance and that this is equal to the frequency impressed by the oscillator.

(b) In general, the sketches were adequate. In the scripts of weaker candidates it was often difficult to judge at what frequency the new peak appeared and whether it was flatter than the given peak. Some lines appeared to be parallel to that already drawn on the graph.

(c) Some candidates gave statements of the laws without relating them to the given situation. Frequently it was not made clear why an e.m.f. would be induced or where the currents would be induced. Very few candidates discussed energy/power losses brought about by these induced currents and the consequent effect on amplitude of vibration. Most were content to say that, by Lenz's law, there would be a force opposing the motion of the plate.

Question 4

(a) It was expected that reference would be made to the electric forces that would be experienced by an atom, resulting in an electron being lost from the atom. Very few answers went beyond a vague statement that involved the term 'ionisation'.

(b)(i) In most answers, a correct expression for electric field strength was quoted. However, many candidates lost marks because they failed to give the field strength in volts per metre or they used the diameter in centimetres rather than the radius in metres.

(ii) A serious error was evident in a significant number of scripts. Candidates stated, quite correctly, that $E = -\Delta V/\Delta x$ but then went on to state that, based on this equation, the field due to a spherical charge is given by $E = V/r$.

(c) The most common answer was increased humidity. Surprisingly, very few mentioned either an object placed near to the sphere or to roughness of the surface of the sphere.

Question 5

(a) Candidates should be advised that, where a derivation is required, then explanation is important. In many scripts, an equation relating magnetic force to centripetal force was written down without any explanation.

(b) This was done well by more able candidates but in lower-scoring scripts, the ratio of the masses was frequently given as 4, with the charge ratio as 1.

(c) There were many errors as a result of incorrect substitution. Surprisingly, very few candidates divided their answer in **(i)** by the ratio calculated in **(b)** in order to find the radius for the β-particle. Instead, they preferred to repeat the longer calculation used in **(i)**.

(d) Although most candidates did show the deviations in the correct directions, many did not relate the calculated radii to the dimensions given for the field. Candidates were expected to show the relative magnitudes of the deflections and not just their directions.

Question 6

(a) Answers were disappointing. Very few candidates stated that yttrium would have greater binding energy because the strontium gives off energy when it decays. Most thought that the strontium would have the greater binding energy 'because it gives off energy when it decays'.

(b) Most realised that decay constant is concerned with a probability of decay. Just what would decay, and in what period of time, was frequently highly confused. Candidates must learn to distinguish between atoms, nuclei, nuclides and isotopes.

(c) In general, the calculations involving radioactive decay were done well. As is usually the case, there was confusion amongst less able candidates as to how to convert a number of nuclei to a mass. That is, a calculation involving the Avogadro constant.

Paper 9702/05

Practical 2

General comments

The general standard of the work by candidates was similar to last year, and the Paper produced quite a wide spread of marks. **Question 1** proved to be accessible to most candidates. However, as in previous years, many candidates found the design question difficult, and a large number of scripts were seen where the marks for this question were very low.

A number of Centres had difficulty in obtaining power supplies which were capable of delivering a continuous direct current of 5 A. However, it was still possible to perform the experiment with smaller values of current, and candidates from these Centres were not penalised on this occasion. However, power supplies of this type are considered to be essential in the study of practical physics and it is recommended that Centres make every effort to ensure that basic equipment of this type is available to candidates.

Comments on specific questions

Question 1

In this question candidates were required to investigate the relationship between the current in a copper wire and the orientation of a magnet suspended near to the copper wire.

Most candidates were able to set up the circuit correctly and take six sets of readings for θ and *I*. There were a few reported cases of assistance given to candidates by Supervisors in the construction of the circuit. It was disappointing to see many candidates not repeating the readings. Values of tan θ were usually calculated correctly, although a number of weaker candidates misread the protractor and gave impossible readings of deflection (i.e. θ > 90°). Most candidates presented the results in tabular form with correct column headings. Values of θ and *I* were usually given to an appropriate degree of precision.

Candidates were required to justify the number of significant figures that they had given for tan θ. It is expected that candidates will relate the number of significant figures in θ to the number of significant figures in tan θ. A number of weaker candidates misunderstood the question and merely stated the number of significant figures to which tan θ had been quoted. Some vague answers were seen where candidates had referred to 'raw data' instead of values of θ.

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 one Ampere). Lines of best fit were drawn reasonably well. In the calculation of the gradient candidates are still using points on the line that are too close together, resulting in inaccurate values for Δx and Δy. 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 candidates seemed to find the analysis section more straightforward than last year, and many were able to equate *k* with the gradient of the line, although many omitted the unit, or gave an incorrect unit (e.g. $^{\circ}$ A^{-1}). Some candidates attempted to calculate a value for *k* by substituting values into the equation. This was not credited since the question requires candidates to use their answer from **(b)(ii)** to *state* the value of *k*. A mark was awarded for the candidates who gave *k* to a sensible number of significant figures (two or three). This mark was given to most candidates who managed to obtain a value for *k*.

In part **(d)** many of the more able candidates were able to perform the calculation to find the deflection θ for a current of 15 A, although many of these candidates were not able to state why it may be difficult to verify this experimentally. It was expected that candidates would state that there would be heating problems or that the fuse may blow on the power supply unit. However, a large number of vague or incorrect responses were seen, such as 'It would be too dangerous', 'The resistance of the circuit would change' or 'The oscillations of the magnet would be too large (?)' which were not credited. A number of candidates stated that the current could not be measured since the maximum reading on the ammeter was 5 A.

Question 2

In this question candidates were required to design a laboratory experiment to investigate how the count rate due to γ-radiation depends upon the potential difference across a Geiger-Müller tube.

Answers to this question were generally quite disappointing. It was clear that many candidates had never used or even seen a Geiger-Müller tube, and numerous accounts were given where the whole experiment had been done inside the Geiger-Müller tube itself, or where the experiment was completely unworkable. For example, it was common to see many of the weaker candidates suggesting the use of a CRO to measure the count rate. If it is not possible for candidates to do experiments or see demonstrations involving radioactive sources then it may be helpful if they could watch a video recording illustrating some of the basic ideas.

Candidates were required to select one of the sources in the table for use in the investigation. It would have acceptable for candidates to use either the radium-226 or cobalt-60 source since both of these produce gamma radiation and have long half-lives. However, a very large number of candidates (certainly more than half) chose the Bismuth-214 source. Often the reason given was that 20 minutes was a long enough time interval in which to perform the experiment. There was much confusion with half-life experiments. Many weaker candidates lost marks by stating that the half-life of the radium or cobalt sources was too long to carry out the experiment. Very few candidates gave a correct reason for their choice of source (i.e. that the half-life of radium or cobalt is so long that the activity of the source would not change appreciably during the course of the experiment).

Marks were available for a well-drawn diagram showing how the apparatus would be arranged. It was expected that a voltmeter would be shown in parallel with the Geiger-Müller tube or the power supply, and that the terminals of a ratemeter or scalar would be joined to the Geiger-Müller tube. A number of candidates had voltmeters in series with the tube, or had a single wire connecting the GM tube to the ratemeter. Diagrams usually contained a sheet of aluminium between the source and the tube for absorption of β-particles. Thin lead was also accepted.

Weaker candidates often had little understanding of the control of variables, and described experiments where the distance from the source to the tube had been varied, or the thickness of the aluminium sheet had been changed. Some candidates used all three radioactive sources in succession.

Candidates were asked to state any safety precautions that they would take when carrying out the experiment. Many candidates gave answers that were unreasonable. ‘Wear lead suits/goggles/gloves’ or ‘Perform the experiment in a lead-lined room’ are not acceptable. Sensible suggestions relating to the use of radioactive materials in schools or colleges were expected. Some of these might be ‘Use a source handling tool’; ‘Do not point the source at anyone’; ‘Do not look at the source directly’; ‘Store the source in a lead-lined box when not in use’. It was disappointing to see so many candidates not even suggesting any safety precautions.

As in all previous questions of this type, two marks were available for good further detail. Many of the more able candidates scored here. Some examples of creditworthy points are as follows:

- Keep the distance from the radioactive source to the tube constant
- Subtract the count rate due to background radiation from the readings
- Aluminium sheets used to absorb the β-radiation are a few millimetres thick
- Repeat the readings (to allow for the random nature of radioactive decay).

Paper 9702/06
Options

General comments

Option F (The Physics of Fluids) and ***Option P (Environmental Physics)*** were by far the most popular options. However, it did not appear as if candidates found these options easier than any of the others. In general, higher marks were scored in those Centres where only two Options had been studied.

It was pleasing to note that fewer candidates used non-scientific language when answering questions. It is important that candidates base their answers on the physics of situations, rather than general, uninformed comments.

Candidates appeared to have sufficient time to complete their answers and there were fewer than usual blank spaces in the middle of answers.

Comments on specific questions

Option A: Astrophysics and Cosmology

Question 1

(a) It was expected that candidates would state that a star is a mass of gas giving off e.m. radiation. In general, these points were made. Very few went on to give any further detail for a third mark.

(b) This was answered well, with some detail being given about the ‘large group of stars’.

(c) Most candidates did state that a planet is a body that orbits a star and is seen by reflected light. Very few gave any further detail (such as rocky or gaseous) for a third mark.

Question 2

Nearly all answers included a statement that the (fractional) change in wavelength is related to the speed. However, there were very few clear statements as to how this change is obtained by observation of spectra on Earth and from the galaxy.

Question 3

(a) Calculation of the Hubble constant presented very few problems, possibly because units did not have to be considered.

(b)(i) It was necessary to convert a distance in parsec to one in metres. Although this question should be routine, there were many problems experienced by candidates.

(ii) There were very widely varying estimates for the Earth-Moon distance. Candidates did not seem to realise that all that was necessary was to divide the estimate by the answer in **(i)**. Rather, most took the value of H_0 in **(a)** and, once again, laboriously converted units.

(c) There was a number of very good answers here, where there was an appreciation of the concept of a local cluster of galaxies. However, many candidates merely stated that, as a result of the Big Bang, galaxies would be rushing past one another.

Option F: The Physics of Fluids

Question 4

(a) In general, candidates experienced little difficulty, apart from confusing the mass of ice immersed in the water with the total mass of ice.

(b) There were very few convincing arguments and those who did state that the level would not change usually appeared to do so through guesswork. The most common answer was that the level would rise. Despite being given the hint in **(a)**, candidates failed to register that the density, and hence the volume, would change on melting.

Question 5

(a) Most candidates could give three conditions. However, they should be warned not to duplicate answers, such as giving two conditions as ‘incompressible’ and ‘constant density’.

(b) There were some good answers given here but the majority failed to make the important link that the high-speed train causes air near the train to move faster than the air on the opposite side of the passengers. Instead, they totally ignored the air and stated that the high-speed train causes a low pressure and the pressure difference pushes people towards the train.

Question 6

(a)(i) In many answers, a reference was made to ‘streamlines crossing’. Since the tangent to a streamline gives the instantaneous direction of motion, streamlines, by definition, cannot cross. Candidates should appreciate that it is the pattern of streamlines that is always changing.

(ii) A significant number of candidates wrote about styling or stability of the car. Very few considered that turbulence gives rise to additional kinetic energy of the air and that this additional energy must be derived from the car’s fuel, thus increasing fuel consumption.

(b)(i) Surprisingly, a significant number of candidates did not realise that C_D is a constant associated with drag.

(ii) The only real problem in this derivation was with candidates who did not explain their working.

(iii) This calculation discriminated against weaker candidates who either failed to convert the power to watts or who found the square root, rather than the cube root.

Option M: Medical Physics

Question 7

(a) Answers were disappointing in that the vast majority dealt either with the continuous distribution of wavelengths, or with the line spectrum. Both aspects were expected. Furthermore, many answers included lengthy descriptions as to how to produce the electron beam in the X-ray tube.

(b) It was clear that the majority of candidates did not understand how the X-ray beam is controlled. In **(i)** and **(ii)**, very few made reference to which potential difference must be varied. In **(iii)**, the use of a lead grid was usually quoted.

(c) For the more able candidates, the calculation presented very few problems. Surprisingly, some answers involved direct proportionality.

Question 8

(a) This was poorly answered. Some thought that a powerful lens would make the beam more powerful. Some did mention that the intensity of the beam (at the focus) would be greater. However, for the second mark, some benefit of increased intensity in a small region was required.

(b) The reason given for less bleeding was frequently quoted as greater accuracy and precision of cutting. Cauterisation and coagulation were rarely mentioned.

Question 9

(a) A common error was a failure to state that sensitivity is concerned with *changes* in intensity, not the minimum intensity that can be detected. Some quoted sensitivity as being proportional to $\Delta I/I$. This would mean that sensitivity decreases as the minimum detectable change decreases.

(b) Most answers included a statement of the equation by which intensity level is calculated. A common error was to calculate the intensity for a 3 dB change from I_0. Others did not calculate the change in intensity but rather, gave the answer as the new intensity.

Option P: Environmental Physics

Question 10

(a) In many answers, there was no indication of what is meant by a fuel. The word 'fuel' is italicised in the question and should, therefore, have been included in the answer. A surprisingly large number of candidates included humans as part of the partially decayed organic matter!

(b) The distinction between resources and reserves was widely known but some candidates had difficulty in expressing themselves clearly.

Question 11

(a) Some descriptions were very good. The usual omissions were a failure to state that the fission products are of approximately the same mass and that energy is produced along with the emitted neutrons.

(b) The role of the moderator and of the control rods was known by most candidates. However, most thought that the only purpose of the reactor vessel is to act as a biological shield. The fact that it maintains the coolant around the core and is part of the heat exchange circuit were not included.

Question 12

(a) The formula for the maximum efficiency was quoted correctly in nearly every case. However, the vast majority substituted temperatures in Celsius, rather than Kelvin, when calculating the efficiency.

(b)(i) It was expected that candidates would make reference to major contributing factors such as exhaust gases and losses from cooling towers. However, many mentioned minor factors such as losses from pipes and friction in the turbine.

(ii) As in **(i)**, minor considerations, such as more lagging on pipes and lubricating the turbine, were frequently stated. CHP was sometimes mentioned, together with raising the temperature of the steam entering the turbine.

(c) Despite being told to consider pollution other than from exhaust gases, acid rain was frequently quoted. Thermal pollution and visual pollution were acceptable alternatives.

Option T: Telecommunications

Question 13

(a) The completion of the table for the signal in mV presented very few problems. However, less able candidates found difficulty with the binary notation.

(b) Although the points on the graph were usually shown in the correct positions, many did not realise for which time interval the received signal would remain constant after the signal voltage had been sampled. There were numerous examples of histograms.

(c) Most candidates did mention a higher sampling frequency and a larger number of bits. However, the reasons were usually expressed vaguely as 'less grainy'. Detail as to 'step height' and 'tread' was required.

Question 14

(a) Some diagrams were very good, and most did show the relevant features.

(b) Most could give three reasons, although some were not expressed very elegantly. For example, 'more information carried' was presumably meant to mean 'greater bandwidth'.

Question 15

This question was poorly answered. Many of the wavelengths and ranges quoted bore little resemblance to the accepted values.