PHYSICS

Paper 9792/01
Multiple Choice

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

General comments

This was the first paper that tested both section A and section B of the syllabus. The paper proved to be appropriately set and it would appear that all the candidates managed to answer the paper in the time available. Candidates appeared to have prepared well and have a good understanding of all parts of the syllabus. Closer inspection of the item level data indicates that overall candidates did not find the section B questions more difficult than the section A questions.

All of the questions showed a positive discrimination. There was again a good spread of marks with a mean 29 and a median of 30 marks – slightly lower than the last year; ten candidates scored either 39 or 40 marks.

On part A of the syllabus **Questions 1**, **2** and **3**, which tested the mechanics section were answered very well by all candidates. **Question 15** on determining speed of waves and **Question 19** on the topic of radioactive decay based on a number of integer number of half-lives were also well answered.

On part B of the syllabus **Questions 23** and **24**, which tested circular motion, were answered very well by all candidates. Other questions answered well on this part of the syllabus were **Questions 27** and **33**.

The questions on this paper do require careful reading and candidates are advised to reflect carefully before recording their response. Care also needs to be taken over questions where there is a '**not**' in the stem of the question. Candidates also need to practise answering questions which require the manipulation of equations such as **Questions 7**, **16** and **28**.

In each section A of the syllabus there were four questions that candidates found very difficult while there were two questions in Section B of the syllabus.

In section A of the syllabus **Question 9** indicated that the idea of 'tough' materials was not fully understood with all the other distractors used by the candidates, suggesting that perhaps some of the candidates guessed the answer.

Question 12 tested potential difference in a series circuit containing two cells, both with internal resistances. In reality this was a simple application of Kirchhoff's second law. One common incorrect answer was **B** where candidates carried out a simple subtraction of the emfs. The other common incorrect answer was **C** where candidates of the cells and ignoring the internal resistances) or **D** where candidates correctly allowed for the internal resistances but did not take into account the algebraic sum of the emfs.

Question 17 tested displacement time graphs for two waves. Some candidates were confused as to which wave was leading and which wave was lagging.

Question 22 was a difficult question on the effect on both the number of photoelectrons and the maximum kinetic energy of the photoelectrons for different monochromatic radiation at the same intensity. Approximately half the candidates thought that the maximum kinetic energy would be greater but also incorrectly thought that the number of photoelectrons would also be greater. Candidates did not fully understand the term 'intensity'.

In section B of the syllabus **Question 28** was another question that tested candidates' ability to manipulate equations. In this case candidates needed to reason the effect that changing the radius would have on the mass of the oil drop as well as remembering that the charge had changed. The most popular incorrect answer was **C** where the change in charge had been omitted. Some candidates assumed that the radius of the drop would have no effect and chose **A**.

Question 37 was a difficult question on radioactive decay. In particular, candidates needed to understand the meaning of "the present ratio of strontium-87 to rubidium-87, after correcting for the presence of strontium when the meteorite formed, is 0.072". Candidates also needed to determine the decay constant before determining the final answer. Correct working yields an answer of 4.89×10^9 years which should have been **B**. The figure given in **B** was incorrectly written on the question paper and thus the question was discounted so that no candidate was disadvantaged.

PHYSICS

Paper 9792/02

Paper 2 Written Paper

Key messages

The Pre-U Physics syllabus is slightly different from previous examination sessions and this has been reflected in a very slightly different paper.

Candidates are strongly advised to show the working that leads to a particular answer. When intermediate steps are performed on a calculator, it is tempting to show only the final answer but it is easy to press the wrong button on a calculator and by showing the working out, this becomes less likely and even when it occurs. There are very commonly marks available for stages of working. Likewise, when calculations are set out neatly in simple steps, the logic becomes clearer and mistakes are less likely to be made. Candidates should ensure that the answer produced by a calculator is of the correct order of magnitude and physically possible before writing it down as the final answer. In more descriptive answers, candidates do not need to produce answers in complete sentences and very frequently, bullet points or lists can make the point more clearly.

General comments

There is usually a great deal of space on a paper like this and candidates are advised to make use of this so that diagrams are clearer and answer well set out. A crossing out followed by a new version of the answer is usually better and clearer than an attempt to modify what has already been written or than an answer written in between crossed out previous answers. This helps a candidate to see what has been written and it is easier to notice if this is what was intended.

Comments on specific questions

Question 1

(a) Both parts of this section were well understood and usually correct. The question supplies the quantity *A* and so it was suprising that some candidates gave the answer in terms of πr^2.

(b) (i) This calculation used the formula derived in **(a)(ii)**. It was usually correct. The question gives numbers that are correct to three significant figures and so this is the best way for a candidate to present the answer.

(ii) Most candidates were able to supply sensible and plausible suggestions here and this part was generally well answered. The precise manner of the variations in salinity or in the gravitational field strength need not be known by the candidates and so for these suggestions, both an increase or a decrease in density was considered sensible.

Question 2

(a) Many candidates produced a correct derivation and many used a method that involved integration. Some candidates who performed less well on the rest of the paper, were unable to produce a plausible explanation for the factor of ½ in the final formula.

(b) (i) These two parts were well answered and very commonly the correct answer was supplied. Some arithmetic errors were made here.

(ii) This question was well answered by most candidates and full credit was very commonly give here.

(c) Again, this was very commonly well answered but a small minority of candidates substituted the mass of the lorry for *R* in the expression $\mu_k R$.

Question 3

(a) Many candidates were not awarded full credit as their sketched diagrams bore very little resemblance to how the vector triangle should have appeared. The word *sketch* in the question indicates that an exact, scale diagram is not required. The diagram did need to show how the vectors were related and diagrams that were not even approximately correct did not do this.

(b) (i) This was usually answered correctly.

(ii) Many candidates obtained the correct value for the speed of particle Y but those who used a conservation of momentum approach often ignored the vector nature of momentum and did not calculate the answer correctly.

(c) This part proved quite challenging and only the strongest candidates realised the approach that was needed here. The significance of the elastic collision was rarely appreciated and many candidates gave answers that were restricted to the speed values given in the stem. The question was asking for a more general case.

Question 4

(a) This was very commonly correct. Only rarely was the answer given as 6.00 Ω, even though the number supplied by the question are to three significant figures.

(b) (i) The figures in the first column were very commonly correct. The figures in the second column were often calculated correctly although a minority of candidates used an expression such as R/V to obtain the current. When the answer was exactly 0.800 A, the answer 0.8 A was accepted but many candidates gave other figures to just one significant figure and this was not accepted. The last column was for the output power of the heater and in the formula I^2R, the resistance *R* is the resistance of the heater that was deduced in **(a)**. Many candidates used the resistance of the complete circuit and did not obtain the correct values.

(ii) Only the strongest candidates realised that the uneven winding of the resistor wire might compensate to some extent for the uneven variation of the power of the heater with resistance.

Question 5

(a) This part was well answered with many candidates suggesting an appropriate observation. The word *diffraction* was used by many candidates to describe *dispersion*.

(b) (i) Many answers were awarded full credit, although occasionally, a wrong refractive index was used in the calculation.

(ii) This was very frequently correctly answered.

(c) (i) This was often well answered and full credit was commonly awarded. A few candidates produced an answer using the speed of light in a vacuum rather than that calculated in **(b)(ii)**.

(ii) Many candidates realised that the different possible paths would cause an elongation of the signal. Fewer candidates made any reference to the attenuation in the signal strength caused by the absorption of energy by the fibre itself.

(d) (i) Although only a minority of candidates were awarded full credit here, more candidates made at least one of the points that were expected and obtained some credit.

(ii) The most common correct answer was the suggestion that a very narrow core be used. The other possible answers were only rarely given.

Question 6

(a) (i) This was very commonly correct but answers given in terms of π or as fractions were not accepted. The unit was sometimes given as π.

(ii) The majority of candidates gave the correct answer and explanation.

(b) (i) These answers were very commonly correct. A small number of candidates used the values 0.5 and 1.5 for *n* rather than 1 and 2.

(ii) Some candidates interpreted the word *sketch* much too loosely and produced a diagram that was lacking essential detail.

Question 7

Many candidates found this question quite challenging. The lack of any structure or of any suggestion as to the information that could be extracted from the readings left some candidates unsure of how to proceed. The candidates who performed well on the rest of the paper, however, gave rather more detailed answers here.

Question 8

(a) Many candidates were familiar with the calculations in these four parts and the majority of candidates were awarded full credit for this part. There were, of course, a few candidates who made arithmetic errors but errors of physics were rare.

(b) This question led to many candidates producing answers that only partially fitted what was asked for. The question is set in a particular context and the best answers took this context into consideration and restricted the discussion to this case.

(c) (i) This question was well answered by some candidates but others were not able to explain why the photoelectrons have varying amounts of energy. Some answers were given in terms of varying work functions or varying photon energies.

(ii) There were some correct answers here but many answers suggested or implied that the filament lamp was producing monochromatic light of wavelength 380 nm.

Question 9

(a) (i) This was very commonly answered correctly.

(ii) There were many correct answers here.

(b) (i) The answer here was most easily obtained from the formula mgh / t. A value for h at high tide can be obtained from the graph in Fig. 9.1. Only a minority of candidates did this and the answers produced covered a large range.

(ii) This was sometimes correct but more commonly it was awarded full credit as the wrong answer in **(b)(i)** was used correctly.

(iii) This was sometimes correct but more commonly it was awarded full credit as the wrong answer in **(b)(ii)** was used correctly.

(c) (i) This answer was very often correct; the commonest source of inaccuracy was the use of a factor of 3600 even though the power was expressed in kilowatt-hours and the number of seconds in an hour is not needed.

(ii) This part was commonly interpreted to be asking why the efficiency of the power station is not 1.00 (100%). This is a separate issue and although some candidates were awarded full or partial credit, they were in the minority.

(d) Few candidates discussed the origin of the energy that is used in the power station in terms of energy although more were able to state and sometimes explain the effect of the power station on the Earth.

(e) (i) Many candidates were awarded full credit in this part.

(e) (ii)1 Stronger candidates were able to extract from the table the relevant information for use in a formula that is generally given in term of symbols. Weaker candidates sometimes forgot the powers in the formula. This led to a wide variation in the answers obtained.

(ii)2 This was often well answered although few candidates work out the ratio in terms of symbols first; this would have led to a rather more straightforward calculation.

(iii) Some candidates stated that spring tides occur when the Sun and moon are aligned and made no mention of the Earth. In general, the answers were correct though sometimes incomplete.

PHYSICS

Paper 9792/03
Paper 3 Written Paper

General comments

The number of candidates taking this paper increased again this year. Many candidates were able to answer the required ten questions. As usual, the paper was answered very well indeed by a large number of able candidates. Many candidates were able to score over 120 out of the 140 marks available. Some candidates answered all the mathematical questions but very few answered all the philosophical questions.

The handwriting of some candidates was poor. When dealing with algebra, candidates did not always define the quantities clearly.

Comments on specific questions

Section 1

Question 1

Most candidates answered this question well. Parts **(b)** and **(c)** were done well but many candidates, when answering part **(iii)**, did not realise that at infinity the gravitational potential energy and thus the kinetic energy and the total energy would also be zero. It was expected that candidates would refer to the very slow speed long before Mars' gravitational force would become significant.

Question 2

This question was answered well by most candidates, though a significant number started their sketch graphs at 0,0 and not at the driver amplitude.

Question 3

Some aspects of the shape of the field could have been better drawn, with some of the field spreading to the outside and with the equipotential lines being at right angles to the field lines. All candidates received one mark for **(c)(ii)** due to an error on the paper.

Question 4

This question was answered poorly by many candidates. Part **(a)** is a standard experiment and the method used for finding the extension, and the theory required to obtain a value for the Young modulus should have been clear. Part **(b)** needed candidates to realise that a sudden force was required.

Question 5

Most of this question was answered well but **(b)(i)** and **(b)(ii)** caused problems for many candidates. The key point is to realise that, for a complete cycle, D must take the internal energy back to its starting point, giving the increase in internal energy for D as –844 J. Many candidates had an overall efficiency of 100% but the work output is (936 – 702) whereas the energy supplied to the gas is 936 J (of which 702 J are wasted). The efficiency is therefore 234/936 or 25%.

Question 6

This question was answered well by most candidates.

Question 7

This question was answered well but few candidates realised that the problem is not a problem of penetration of radiation but one of keeping the radon–222 out of the house. This can be achieved by using a polythene sheet membrane 0.3 mm thick; there is no need to using thick concrete materials.

Section 2

Question 8

Of the mathematical questions, this question was the least popular question and the fewest percentage of candidates obtained full marks. For those candidates who did answer it, **(b)(iii)** caused the most difficulty. Part **(d)** was generally answered well.

Question 9

Some good marks were obtained on this question but, without doubt, part **(b)(i)** was the most challenging. Too many candidates showed an upward force on the man, giving a resultant force of zero. Here, acceleration requires a resultant force and it must be downwards. There is no upward force. The resultant of the man's weight downwards and the (small) downwards contact force from the cage cause the acceleration towards the centre of the circle.

Question 10

This question was answered well by almost all candidates. One unusual answer from many candidates, for part **(c)(ii)**, was that 'gravitation is always an attractive force but electrical forces are always repulsive'.

Question 11

This was the least popular of the questions in **Section 2**. One difficulty for candidates with the question was that they tended to write at length on just one aspect of each part of the question.

Question 12

This question was answered well, with candidates able to give good answers to all four parts of the question.

Question 13

This question was more difficult for candidates to gain marks as often a single sentence answer tended to be brief and concentrate on one aspect of the question only.

PHYSICS

Paper 9792/04
Personal Investigation

General comments

As with previous years, there was a good range of interesting topics. Good candidates clearly enjoy the experience and benefit greatly from the Personal Investigation. Candidates appear to have been suitably prepared. The majority of Centres take a large amount of care with regard to the marking, checking the marking and internally moderating the marking. This is very helpful.

Centres are reminded that a 'best-fit' approach should be used when applying the criteria to an individual candidate's plan and report. It was pleasing to see that the '0' mark was being awarded appropriately in some cases. Centres need to be wary of giving a higher mark by giving the benefit of the doubt. Throughout the criteria, if a Centre believes that a candidate should deserve a higher of the mark, on balance, then the script must be annotated and if a similar situation arises later then the higher mark should not be awarded. Annotation of candidates' work is essential and in particular candidate errors(s) should be highlighted so that the Moderator is aware that the Centre has allowed for the errors in the marking.

When moderating the samples of work differences occur most often in the award of marks for the quality of physics, data processing and communication. Work that lacks the necessary detail should not be given six marks for these criteria. There was a tendency to give benefit of doubt marks to higher scoring candidates particularly with regard to these criteria.

One of the purposes of the moderation process is to confirm the marks awarded by a Centre. It is thus very helpful where a Centre has annotated the script either to justify the award of a mark or to indicate why a mark has not been awarded. It was clear from the moderation process that the majority of Centres marked the tasks carefully and it was pleasing to see many helpful annotations. A number of Centres enclosed annotated copies of the marking criteria whilst one Centre produced a small comment on each of the criteria areas justifying the mark. Other Centres included their own check lists. Some markers also wrote a rationale as to why the marks were awarded – this again very much assists the moderation process. It is obviously helpful that both good physics and wrong physics in the reports are highlighted so as to judge the award of the appropriate mark. It was clear that the larger Centres had carried an appropriate 'internal standardisation' process.

This year fewer candidates included photographs of their investigation. Candidates should also not be concerned about producing computer generated diagrams – labelled hand-drawn diagrams are acceptable and often give better detail. Candidates should also avoid jut producing excel graphs without thought to the scales and axes. Large quantities of data should be included in clearly labelled appendixes.

Comments on applying the criteria

Initial Planning

It was useful when candidates clearly indicated where the plan ended and the report and their investigation started. Four marks should be awarded for appropriately detailed work. For the award of two marks candidates must include a summary of how the investigation might develop. For the award of four marks, candidates should use the pilot experiment to explain clearly how the investigation may develop.

Organisation during the two weeks of practical work

Centre's comments were very helpful in justifying the award of the marks. Some Centres included candidates' laboratory books which indicated candidates' progression in their investigation. Candidates should be encouraged to date their records. For the award of two marks, Centres should be satisfied that candidates are analysing and interpreting each experiment as it is completed.

Quality of Physics

As has already been mentioned, Centres still tend to be too generous in the award of marks for the quality of Physics. Good candidates explained how the Physics used was related to their investigation. For the highest possible marks, candidates should be explaining Physics which goes beyond the taught course and their explanations should be both clear and without error – it should not be copied sections of reference material or text book. Where marked find errors it is necessary for the marker to highlight this so that the Moderator is aware that the error has been allowed for in the marking. Large quantities of copied Physics from a text book cannot score the top marks unless there is a clear explanation of how the Physics is used in the investigation There should also be evidence of how Physics principles are used to explain a candidate's results again using the candidates own words.

Use of Measuring Instruments

If a candidate has help in the setting up or manipulation of apparatus then the mark for this criterion is zero. For the award of two or three marks, two experiments must have been undertaken and some further attention is needed to the measuring instruments used. As mentioned in previous years, when data logging equipment is used, there should be some explanation in the report as to how the equipment is being used. This applies in particular to the use of light gates and motion sensors. For the award of three marks, the apparatus is either sophisticated or uses a creative or ingenious technique.

Practical Techniques

For the award of the higher marks, it would be helpful if candidates could include an explanation in their reports of how they are considering precision and sensitivity. This will also assist candidates in the data processing section when determining error bars. Candidates should be analysing their results as the investigation proceeds and as a result it may be necessary to repeat readings or take additional measurements near any turning points. Candidates should be encouraged to explain their reasoning.

Data Processing

This area was still generously awarded. As has been stated in previous reports, some candidates produced many 'Excel' graphs without much thought to scales, plots, lines of best-fit and the analysis of the data – this cannot score highly. For the data processing to be successful there must be clear explanation of how the experiments are being analysed. It was pleasing to see that a large number of candidates added error bars to their data points; however, it was not always clear as to their reasoning and thus the treatment of uncertainties was in some cases generously allowed. A good number of the more able candidates successfully plotted log-log graphs to test for power laws. Often their work was supported by detailed reasoning. For the award of the higher marks there does need to be some sophistication in the work and clear reasoning. Where error bars have been added, some explanation should be given to the size of the error bars. For four or more marks, there must be some treatment of uncertainties which must be clearly explained. In general candidates should be encouraged to explain how they are determining an uncertainty. These higher level marks must be rigorously applied.

Communication

The marks for this section were a little generous in places. It was pleasing to see a number of stronger candidates include glossaries which were detailed. Candidates should be encouraged to include detailed references which include page numbers. Some of the reports were excessively long and thus were not well organised and did not have a clear structure; verbose reports should not be given six marks. It is also expected that candidates who are achieving the highest marks in this area include aims and conclusions for each practical and for any mathematical analysis. This particularly applies to the treatment of uncertainties. References used should enhance the report. It should be noted that for the award of four marks, sources identified should include page numbers. References should clearly indicate how the material has been used to enhance the investigation.

Finally

To read the investigations has again been a very interesting experience. As has been stated in previous years the Personal Investigation relies very much on the care and attention to detail of individual Centres both supervising the investigation and the assessment of the candidates' work. It was clear that Centres approached the Personal Investigations professionally.